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STEEL TORPEDO BOATS.

THE important part now played in naval warfare by light and swift craft carrying torpedoes has lately given a marked impetus to invention in this direction. Nor is the interest in the subject diminished by the notorious fact that a very small percentage of torpedo attacks have proved successful. This circumstance has, on the contrary, still further increased the rivalry among those manufacturers who are endeavoring to produce the torpedo boat of the future. The causes of failure in craft of this description, as hitherto constructed, are not far to seek; in the majority of cases, ordinary boats have simply been "converted" to their new purpose, being neither made rifle-proof nor properly fitted with the necessary appliances for their service. Present requirements are now, however, inaugurating a new era in naval architecture, and many are the designs put forward of these accessories to a sea engagement.

Our illustrations present the elevation, plan, end view, and part section of a new torpedo launch, fitted with Whitehead torpedo-gear, which has been carefully designed throughout for its special purpose by Messrs. Wigzell, Halsey & Co., of Mark lane, whose engines attracted considerable attention at the last Smithfield Show. In these vessels, every detail is adapted to its specific purpose, while all the parts are arranged so as to be as snug as possible. They make no noise in their swift passage through the water—from which they are almost indistinguishable, owing to their being painted a greenish-gray color—and they emit neither steam nor smoke. For the prevention of the latter, Welsh smokeless coal or coke is burnt, and air is admitted on the top of the fire-grate; the short funnel is also provided with a baffle-plate to prevent the escape of sparks. There is no exhaust, as a surface-condenser is used, the capacity of which is in excess of all possible requirements. Though the vessel is 75 feet long by 10 feet beam, she weighs only from 12 to 14 tons, and can therefore be drawn up like a lifeboat on the beach, and readily launched again when required. She is built with eight water-tight compartments, any two of which are sufficient to keep her afloat. Everything about the vessel, including plates, angles and stays, is of steel; the skin and also the bullet-proof armor on deck, $\frac{1}{16}$ inch thick, are of crucible steel, supplied by Messrs. Samuel Osborn & Co., of Sheffield. Of the remarkable tenacity of their metal we had ocular proof on the occasion of our visit to the works. Not only was the cold plate doubled down flat with a hammer, but it was also doubled over the second time without showing any signs of fracture. This same metal is also of sufficient fineness to make knives and other cutting tools, such as plane-irons. The seams are riveted cold with the best charcoal-iron rivets; and to perform this operation properly men have to be regularly trained to it, ordinary riveters being, as a rule, too heavy-handed. We were informed that a rifle bullet will not penetrate these plates at twenty-five paces with the ordinary Snider charge.

The question has often been raised as to the action exercised by salt water on steel; and, indeed, the subject lately came before the Cleveland Institute of Engineers. The makers have not experienced any difficulty on that score; but, in deference to the fears expressed by some engineers, they have made arrangements for the erection of special apparatus for galvanizing the entire hull, both inside and out, thus saving the necessity of painting and its renewal.

The main engines, of about 250 horse power, are compound, and form the subject of a patent, being very small and light, and can be got into a remarkably small space, thus giving the launches a considerable advantage. A separate engine is provided for driving the air-pump and the circulating pump of the surface condenser. In fact, there are no less than five engines on board, the description of which we must leave to a future article. A speed of 18 miles an hour is, we are informed, guaranteed. The engines are designed to work without any oil for lubricating the cylinders, which leads to saponification in the boiler and a quick decay of the plates. The reason of this has been found to be that, unless a large quantity of lime be present in the feed-water, so as to neutralize the fatty substance, oleic acid is set free, which acts upon the plates and causes them to disintegrate. The engine boiler, of the locomotive type, is capable of being worked up to 120 lbs. per square inch. Steam can be raised in about an hour, but, in order to provide for every emergency, an auxiliary boiler is provided, in which steam at 120 lbs. pressure can be got in a quarter of an hour, long before the boat can be launched and the crew got together. This auxiliary boiler is very light, and consists almost entirely of heating surface; we hope to illustrate it in connection with our article on the engines.

The propeller is a three-bladed screw, with steel boss and blades, the shaft being also of the same metal. Each blade is let into the boss and keyed in separately, endwise, so as to

FIG. 3.

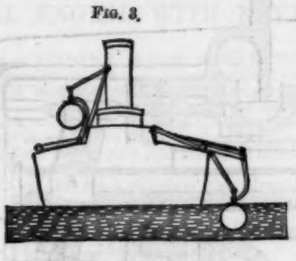


FIG. 4.

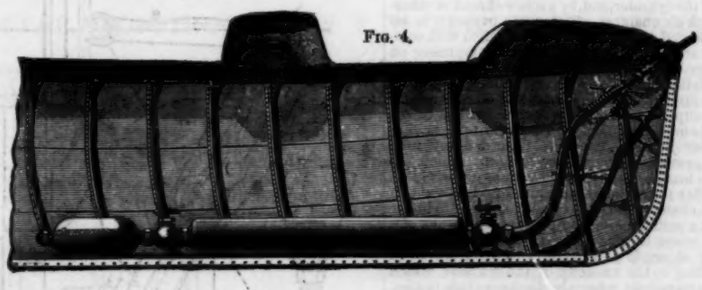


FIG. 5.

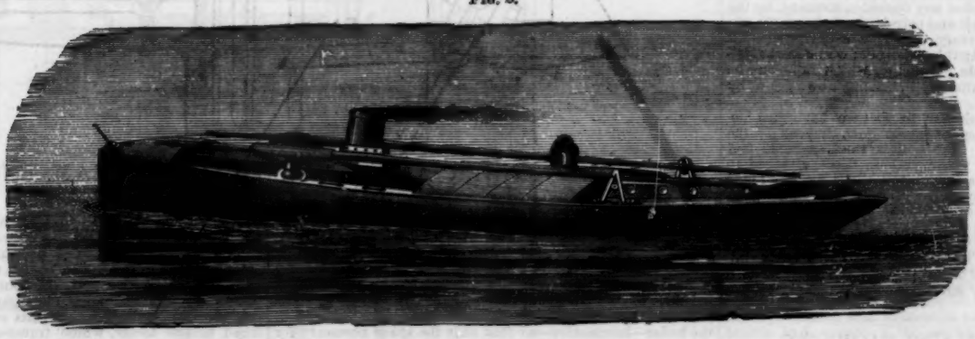


FIG. 1

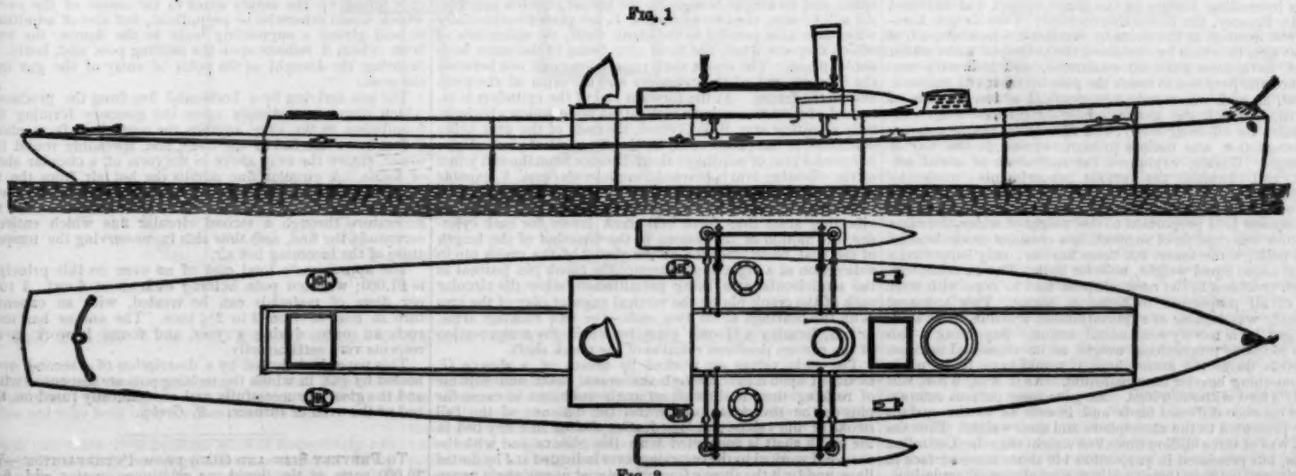


FIG. 2.

IMPROVED STEEL TORPEDO BOATS.

admit of a fresh blade being readily inserted in case of damage. If, however, the propeller should strike a spar, the shock would probably only double it up, and the vessel would be able to proceed with the other two. The screw is composed of four different pitches, its design being the result of much study and calculation. It is arranged with a wave-line entrance, so as to take the water like the bow of a vessel. The extreme ends of the blades are curved, so as to prevent the water from being disturbed in the line of centrifugal force, and thus cause a column of water to be thrown out at the stern.

As the whole of the vessel is inclosed, it is necessary to make provision for artificial ventilation. This is secured and the temperature of the engine-room kept down by a centrifugal fan, 3 feet 6 inches in diameter, driven by a 3-inch three cylinder engine, run at about 13,000 revolutions per minute. This engine, which is similar to that made for propelling the Whitehead or fish torpedo, is made entirely of phosphor bronze. The fan, capable of maintaining a pressure equal to that of a column of water 5 inches high, is of crucible steel.

A height of only 2 feet 6 inches appears above the water, with the exception of the sighting turret, where the officer in command takes his station. By means of speaking tubes he has control over the whole vessel, including the engines and torpedo-lowering apparatus. He also has the steering wheel in front of him, and is able to make for any object by looking through the horizontal apertures in the turret. As the torpedo is contained in a tubular casing, parallel with the vessel, and will make its object within a yard or two in still water for a distance of 400 yards, all that is required is to steer the vessel in the desired direction. The lowering gear for the fish torpedo will be observed in the three general views on preceding page; in the end view, one torpedo case is shown lowered into the water, while the other is raised ready for inserting a torpedo; this knuckle-jointed gear, which is very interesting and ingenious, can be worked from inside the vessel without any exposure to the enemy's fire. The tube is lowered by the chain, and as soon as it reaches the water the vessel's head is turned to the object, and a valve is opened to admit compressed air into a small cylinder at the back of the tube, so as to give an initial impetus to the torpedo. On the torpedo leaving the tube it pulls a trigger, thus opening a valve and setting the engines in motion, when the deadly missile makes its way silently, though surely, direct for its object.

These vessels, however, possess other weapons of offense than the torpedoes. They are fitted with means for discharging Greek fire or crude petroleum to a distance of about 300 feet, within a space of eighteen seconds. This apparatus is shown in the longitudinal section at Fig. 4 (page 1837), and consists of a cylinder of suitable length, diameter and thickness, affixed to the keel of the vessel. A piston is introduced into the aft end of the cylinder, and, by a screw-thread or otherwise, a compressed air chamber of adequate capacity is attached to the same end of the cylinder, being filled with compressed air, at the arsenal on shore or by an air-compressor on board, to a pressure of about 500 lbs. to the square inch. The other end of the cylinder is fitted with a coupling joint, to receive a discharge pipe, of suitable length and diameter, leading to the deck or superstructure of the boat, where it is fitted, by means of a ball-and-socket joint, to a delivery tube, having a nozzle of suitable internal diameter. The delivery tube rests on a stand provided with an arrangement which admits of the nozzle being turned in all directions and elevated or depressed. After the piston has been inserted in the cylinder, and the air-chamber affixed to the aft end, the cylinder is first filled with a suitable quantity of water by means of a funnel. On the water is then poured, through the same funnel, a quantity of crude petroleum, varying from 10 to 60 gallons, according to the capacity of the cylinder, which will fill it up to the stop-cock, where the discharge pipe begins. The stop-cock is then closed, and the liquid contained in the cylinder may be discharged at any desirable moment, by the opening of the respective air and petroleum cocks on the air-chamber, cylinder and delivery tubes. The compressed air pushes the piston forward; the piston, the water in the cylinder; this water, the crude petroleum, which falls on the object aimed at, and is ignited by the enemy's own fire or by an incendiary rocket.

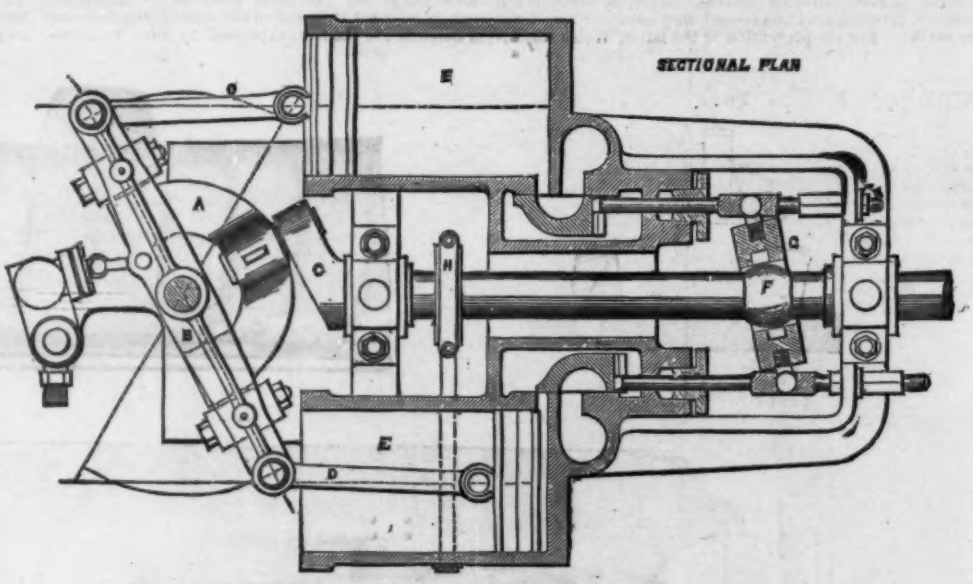
Fig. 5 shows a vessel similar to that we have just described, but fitted with spar-torpedo gear, instead of the Whitehead torpedo gear. The hollow steel spars, 45 feet long, one on each side the vessel, slide in tubes, attached to or rather forming part of a tail-jointed elbow piece. These have two motions; they not only swing clear of the funnel, so as to bring the spars athwartship, but also fall down like the lid of a box, thus bringing the spar on to the surface of the water. These motions are given by wire ropes worked from the inside. The torpedo is either fired by impact, or by electricity after being placed in its desired position. The recoil generally sends back the torpedo vessel uninjured.—*Iron.*

PROGRESS OF FLYING MACHINERY.

AN interesting lecture on the above subject was delivered by Mr. Brearey, the Honorable Secretary of the British Aeronautical Society, at the Grimsby Mechanics' Institute, a few weeks ago, in which he explained the principles upon which aerial navigation must be conducted, and indirectly condemned the proposal to reach the pole by means of balloons. Flight, he said, was merely a mechanical action capable of imitation, that it was unassisted by air cells or other contrivances for effecting levity, and that the balloon as a means of locomotion was useless to man, except in the way of waftage. Having explained the rudiments of aerial science, and detailed the various experiments made by English and foreign inventors, showing what their progress had been, he pointed out the curious fact that light as the atmosphere is in proportion to the weight of water, the rarer medium was capable of supporting a creature much heavier than itself, while water, 800 times heavier, only supported a fish of about equal weight, bulk for bulk. The currents, too, which creatures in the rarer element had to cope with were out of all proportion to those of water. This apparent anomaly was capable of explanation—it was due, as he said, to flight by a merely mechanical action. Supposing a fish bore the same proportional weight to its elemental medium as birds do to the atmosphere, it would have to be made of something heavier than platinum. As it was, a fish was really a bird without wings. He gave some curious comparisons between different birds and insects as to the surface they presented to the atmosphere and their weight. Thus the gnat was of three million times less weight than the Australian crane, but presented in proportion 140 times more surface to the air; and between these two there were almost all gradations. In these investigations lay some of the most hopeful facts which seemed to render aerial navigation possible, and if man could get sufficient surface he could surely get sufficient machine power for propulsion. It was not so much a question of power as of the right application of power. There was also the question of balance. The manner in which a bird kept its balance, while its wings were being energetically worked alternately above and below its center of gravity, was marvelous. Mr. Brearey thought that, with the example of the bicycle, the question of balance would not present much difficulty. He then touched on the application of steam to the navigation of the air. Until lately it had been thought that this was inadmissible as a motive power, because of the cumbrous method of its generation, but it had been declared that when steam could be applied with a weight not exceeding 20 lbs. per horse power the problem would soon be solved. This had been accomplished, and they would hope the prognostication might be true. Man might not be able to reach the mechanism of a bird, but they might all reach the problem in another way. Many were now working at the problem in secret—in secret, partly from fear of ridicule, and partly from want of protection by patent. The attitude of the Aeronautical Society toward inventors was explained, and the lecturer concluded by asking whether he had not shown just cause for further research into this most interesting subject. The lecture had considerable interest added to it by various demonstrations given by Mr. Brearey, illustrating different modes of flight, including flight by projection, gravity, force, surface, and weight, and propulsion by a plane surface. His models of bats swooped down upon the heads of the audience in a manner quite natural. The birds, too, rose and fell in graceful motion as they traversed the air from the platform to the other end of the room, or, swerving to the right or left, bobbed their beaks upon the side walls. One large model of an albatross, with a spread of wing reaching 12½ feet (the average size of the living bird), came to grief upon a gas pendant, just as it was bending its flight into the regions of the upper air. Huge butterflies were also sent flying about the room.

MESSENGER AND CHURCHWARD'S STEAM ENGINE.

CONSIDERING the necessity for reducing the space occupied by marine engines to a minimum it is perhaps somewhat surprising that the possible advantages attending the application for this purpose of the principle of the Z crank have not been made available, at least for launch or small steamboat propulsion. Except, however, with single-acting engines this has not been done with practical success.



MESSENGER AND CHURCHWARD'S STEAM ENGINE.

We illustrate a small launch engine, by Mr. J. Churchward, Dover, England, in which the principle is applied to single-acting cylinders, but which by the employment of trunk pistons may be made double-acting. The result is a very compact engine of long stroke, the height of the engine being little more than the diameter of the cylinders. In small launches the engine is placed under the smoke-box end of the boiler—locomotive—so that only the space necessary for the latter is required, the engine being in otherwise unused space, and its weight brought to the lowest position possible. As will be seen, the two cylinders, E, are placed horizontally with their axes parallel to the crank shaft, on either side of which they are fixed, the three axes being in the same horizontal plane. The crank shaft runs in bearings, one between the forward end of the cylinders and the other at the stern end of the frame. At the forward end of the cylinders is attached a bracket carrying a vertical pin upon which a horizontally vibrating arm, B, is pivoted, the ends of the arm being connected to the piston rods, O, also by vertical pins. Upon horizontal pins or bearings a short distance from the end joints of the vibrating arm is pivoted a semicircular arm, A, capable of vertical vibration, the central portion of this arm being provided with a journal into which the crank pin fits. These two vibrating arms thus form bell-crank levers for each cylinder, the motion of the pistons in the direction of the length of the boat being attended by the thrust of the crank pin in a direction at a right angle thereto, the crank pin journal in the semicircular arm being permitted to follow the circular path of the crank pin by the vertical angular play of the arm A on the bearings at its two ends—the two rocking arms, in fact, forming a Hook's joint, by which the reciprocation of the pistons produces rotation of the crank shaft.

The slide valves are worked by means of a sheave, G, mounted upon a pin through the crank shaft, and capable of rocking thereon through an angle sufficient to cause the pins on the sheave strap to travel the distance of the full stroke of the valves. A long feather sliding in a key bed in the crank shaft is connected with this sheave and with the sheave H worked by the reversing lever indicated at J by dotted lines, and by it the sheave G may be placed at any angle necessary for altering the cut-off, and may be placed on either side of an angle of 90° for reversing the engine. By means of this concentric cam and strap for moving the slide valves, any range of expansion may be used, and the lead remains constant, whatever the range, for both backward and forward running. When the engine is used for stationary purposes, a governor is attached to the fly-wheel, consisting merely of two weighted levers, the inner ends of which are jointed to a cam on the crank shaft, to which the outer end of the feather above mentioned is attached. An arrangement of automatic expansion gear is thus obtained.

Our illustration only shows the design for small single-acting engines, several details of which would necessarily require modification for engines of larger power. One of the 2-horse size has now been at work about eighteen months, and has for a small engine proved very economical in fuel, and shows no particular wear in any of its parts. One new bronze piston ring has been renewed during the time mentioned, but the other ring, being of phosphor bronze, has remained good yet. The engines may be made with any number of cylinders, and the principle of the design has been applied by the inventors to other purposes, as for pumps and water meters.—*Engineer.*

GLASS-MELTING OVENS.

CIRCULAR ovens for melting glass are the most economical, both as regards first cost and the quantity of fuel they require. When wood was alone used as fuel, no others were employed; but since the introduction of coal other forms have been adopted, though circular ovens are still the most numerous.

But hitherto gas, which during the last ten years has been advantageously applied as fuel to ovens of other shapes, has been deemed inapplicable to those of the circular form because of the difficulties—

1. In the admission to the ovens of the gas coming from the producers. 2. In the passage of the burnt gases to the regenerators. 3. In the admission of the hot air coming from the regenerators. 4. In the arrangements for clearing away the overflow of glass from the pots, and of broken or cracked pots, which sometimes occasion the sudden spilling of from 6 to 8 cwt. of glass on to the bed of the oven. 5. In the construction of the gas burners at the point of admixture with the hot air.

These serious obstacles have been overcome by constructing the oven with a central shaft beneath it, about 4½ feet in diameter and 24 feet deep, at the bottom of which a tank of water extends beyond the foot of the shaft. Into this the overflow from the oven and all broken pots are thrown, and, falling on to an inclined bottom, are precipitated sufficiently beyond the foot of the shaft to be easily cleared away every morning. The center of this shaft is occupied by a cast-iron hollow column about 8 feet in height, which pierces through the inclined bottom of the tank and admits cold air from beneath it, and this column again supports a small hollow tower, which traverses the oven and rises to some distance above it. This offers the advantage of not only filling up the empty space in the center of the oven, which would otherwise be prejudicial, but also of admitting to and giving a supporting body to the flames, the heat from which it reflects upon the melting pots, and, lastly, of favoring the draught at the point of entry of the gas into the oven.

The gas arriving by a horizontal flue from the producer, which abuts immediately upon the masonry forming the foundation to the oven, reaches the central shaft at about 6 feet below the bed of the oven, and, spreading round the tower, enters the oven above in the form of a circular sheet of flame. A circular flue admits the hot air from the regenerators immediately below the banks on which the melting pots are placed; and the burnt gases escape to the regenerators through a second circular flue which entirely surrounds the first, and thus aids in preserving the temperature of the incoming hot air.

The approximate total cost of an oven on this principle is £1,000; with ten pots, holding each about 6 cwt., 3 tons per diem of materials can be treated, with an expenditure in coal of from 2 to 2½ tons. The author has used such an oven during a year, and found it work in all respects very satisfactorily.

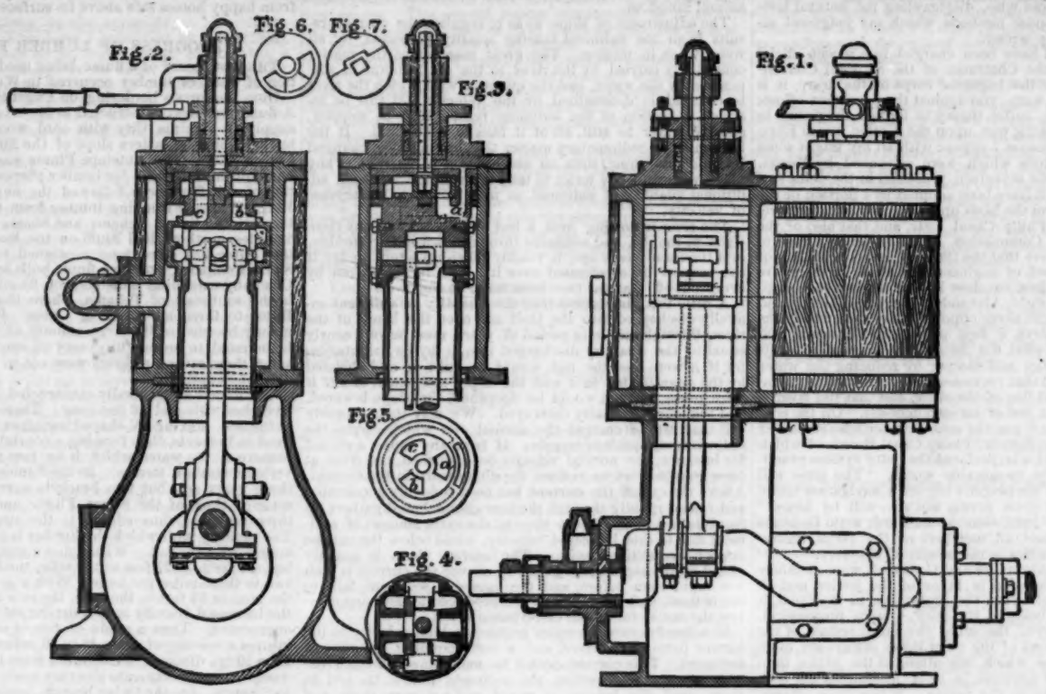
This paper is followed by a description of a second oven heated by gas, in which the melting pots are dispensed with, and the glass is successfully and economically fused on the bed of the oven or furnace.—*M. Greley.*

TO PREVENT SIZE AND GLUE FROM PUTREFACTION.—To 10,000 parts of the liquid, or gelatinous matter, add: Sulphate of zinc, 100 parts; sulphuric acid, 20 parts; tin crystals, 4 parts; nitrate of lead, 4 parts.

VERTICAL ENGINE WITH REVERSING GEAR.

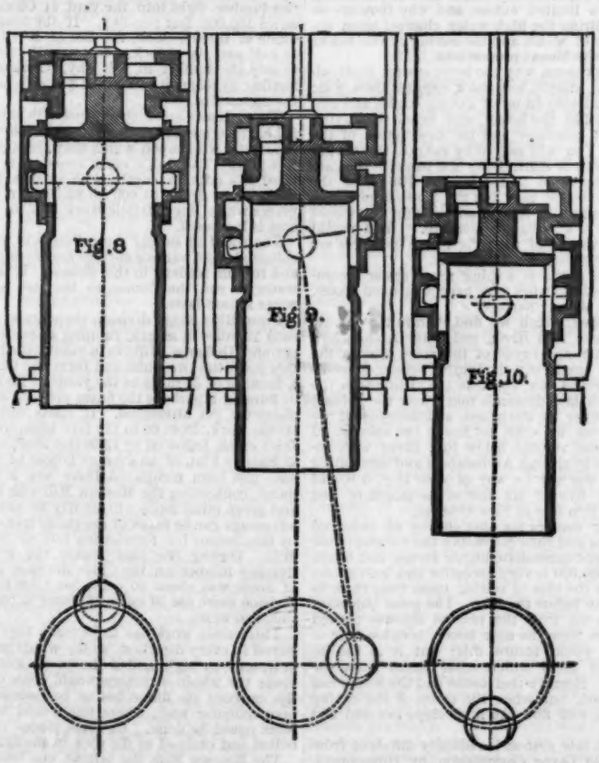
Constructed by F. W. TURNER, St. Albans, Eng.

REFERRING to our engravings, it will be seen that each cylinder contains a trunk piston, the annular space around the trunk being constantly filled with steam from the boiler when the engine is running. Fitted to each piston and sliding on suitable faces are a pair of slide valves, arranged as shown in Figs. 1, 2, and 4, these valves being driven by



VERTICAL ENGINE WITH REVERSING GEAR.—CONSTRUCTED BY F. W. TURNER, ST. ALBANS, ENG.

horns or projections on a valve rod, as shown in Fig. 2. The lower end of this valve rod embraces an eccentric turned on the crank-pin, and the motion of the slide valves relatively to the piston is compounded of the motion due to the direct action of this eccentric, and that due to the oscillation of the valve rod as its lower end is carried round by the crank-pin. This latter motion alone would give the necessary movement to the valves if the latter were without lap or lead, while the eccentric on the crank-pin gives the advance



VERTICAL ENGINE WITH REVERSING GEAR.—CONSTRUCTED BY F. W. TURNER, ST. ALBANS, ENG.

which this lap and lead necessitates. It may be noticed that to avoid any tendency to cant the valves, the horns on the valve rod take hold of the valves close to their working faces.

In each piston are three passages marked respectively *a b c* in Figs. 2, 3, and 5, the openings of these passages at the top of the piston being covered by a reversing valve, which is shown detached by Figs. 6 and 7. Of the three passages, two, *b* and *c*, lead from the face on which the reversing valve works to the two slide valve faces, while the other passage, *a*, leads from the reversing valve face downward, and then returns upward and opens to the upper end of the cylinder, as shown in Fig. 3. The reversing valve is so formed that according to its position either of the passages *b* and *c* can be placed in communication with *a*, and thus either slide valve can be made to admit the steam to the upper end of the cylinder. The direction of motion of the engine is thus determined by the slide valve used. In Fig. 2 the left-hand valve is shown in use, while the passage *b* from the right-hand valve is closed by the blank part of the reversing valve.

The action of the valves can be best traced out by the aid of diagrams, Figs. 8, 9, and 10, which show one of the pistons in three positions, namely, at the top, middle, and bottom of its stroke respectively. Thus, in Fig. 8 it will be seen that steam is being admitted to the top of the cylinder by the left-hand valve, in Fig. 9 the admission is still going on, while in Fig. 10 the exhaust has commenced, and the steam is being released through the left-hand valve into the trunk, down which it passes to the chamber below the cylinders. By turning the reversing valve, the passage of the right-hand valve would be placed in communication with the top of the cylinder, and the engine would run in the opposite direction. Of course it will be understood that during the up-stroke the piston is driven by the constant steam pressure in the annular area of its under side, while during the down-stroke the effective pressure is that on the difference between the upper and under areas of the piston.

Each reversing valve is provided with a square spindle, which slides to and fro in the sleeves shown as passing through the stuffing-box at the top of the cylinder. By turning this sleeve the valve is rotated and the engine reversed; but it will be noticed that, except during the act of reversing, there is no pressure against the faces of the spindle, and hence no inducement for wear. Altogether the valve arrangements of Mr. Turner's engine are very good. The slide valves drain the top of the cylinder, while, as they are driven from their under sides, no stuffing-boxes are required. The port space also is small.

When the lower ends of the valve rods and connecting rods have been uncoupled through the door provided for the purpose, the whole of the working gear can be drawn out through the cylinders, while the main bearings can be taken out by removing the glands at the ends of the casing. The crank-shaft and working parts are of steel, while the various bearings are of large area, and are adjustable. It may be noted that the pin in the piston, taken hold of by the connecting rod, is situated just opposite the exhaust passages, and it is thus lubricated by the exhaust steam.

A five-horse engine of the type we have been describing weighs only 5 cwt., and it forms a compact little motor, handy for many purposes. Of course when a flywheel is used, but a single cylinder is necessary, while some of Mr. Turner's engines are fitted with governors acting on an equilibrium valve. For larger powers Mr. Turner also arranges his engines to work compound, a cut-off valve being provided, and the steam, which during the upward stroke is admitted below the piston, being allowed to expand during the downward stroke, acts on the enlarged area of the upper side of the piston.—*Engineering.*

IMPROVEMENT OF THE MISSISSIPPI.

By J. B. EADS, C. E.

CAPTAIN JAMES B. EADS lately delivered an address at the Cotton Exchange, New Orleans, on the "Protection of Alluvial Lands and the Improvement of the Mississippi River." The hall was filled with members of the Exchange, and there were present, says the N. O. *Picayune*, many of the most prominent and influential merchants of the city.

Captain Eads addressed the meeting as follows, illustrating his meaning by reference to charts of the river:

CAPTAIN EADS' ADDRESS.

Mr. President and Gentlemen: In response to your wish I shall endeavor to explain some of the peculiar phenomena that are observed in all sediment bearing streams when flowing through alluvial districts, and shall try to make you familiar with the causes of these phenomena, so as to enable you to judge correctly as to the merits of the system of improvement which I am urging for that part of the river which lies between St. Louis and the sea.

I shall be compelled to ask your close attention to these preliminary explanations, for although they will appear dry and uninteresting, they are absolutely necessary to insure a correct understanding of the subject. I am sure that when you reflect upon the magnitude of the benefits that can certainly be secured to each and every calling and avocation pursued by the twenty million people who inhabit the grand empire whose concentrated rivulets and streams flow by your favored city in such majestic volume, you will consent to listen patiently and without prejudice to a system of improvement designed to secure the speediest and most permanent possible benefits to the people who occupy the rich alluvial basin of the river, and to the producers and consumers of the products of the seventeen States that constitute the Valley of the Mississippi.

This plan is the result of much thought and a long and intimate knowledge of the river, and as I have no intention of proposing to make any contract or secure any concession from Congress for the execution of the work, and am not anxious even to undertake the direction of it, I can assure you that I have no more selfish motive in the matter than the ambition to benefit my fellow men. I will add, however, that having aided to secure, through the unwavering faith and

substantial aid of others, a deep and permanent outlet to the sea for the grand old river, I intend to devote all the energy and talent that God will give me to secure such a system of improvement for the whole stream as will make it in the highest degree useful for the varied wants of my countrymen.

To this end I shall oppose with tongue and pen every attempt to institute a defective or improper method of improvement for it, and shall not cease to expose the errors and false reasoning of those who, disregarding the natural laws which control it, propose methods which my judgment assures me are radically wrong.

And inasmuch as I have been charged in a recent official letter, published by the Chairman of the St. Paul Convention, with hostility to the engineer corps of the army, it is proper that I should warn you against the persistent efforts of the friends of the outlet theory to induce the public to believe that I am making war upon the United States Engineer Corps simply because I oppose with all my might some of the dangerous errors which were advanced by Messrs. Humphreys and Abbot seventeen years ago in the delta survey report, and which have been adopted by a portion of the corps, and which form the basis upon which the majority report on the Fort St. Philip Canal rests, and that also of the United States Levee Commission. This is simply a ruse to make the public believe that the theories and conclusions of the Humphreys school of engineers are those of the entire corps. It is very unjust to class in that school such engineers as Barnard, Wright, Alexander, Comstock, Merrill and others of the corps who never opposed the system which has given to your commerce a deep passage to the ocean, and who have never adopted the theory that alluvial channels will not become smaller and steeper by reducing the water flowing in them, and that crevasses and outlets will permanently lower the flood-line of the river, and that the river is not flowing through a bed of its own deposits. On the contrary, General Barnard was the sole member who dissented from the views of the Fort St. Philip Canal Board, of which he was President, and who declared the jetty system practical, using, in 1874, the memorable words, "The time will speedily come when the people's cry for a navigation unimpeded by locks—AN OPEN RIVER MOUTH—will be heard." And even as early as 1832, General Barnard, with Generals Beauregard and Chase, all members of the corps, recommended the trial of jetties at the mouth of the river.

Generals Wright, Alexander and Comstock were members of the board which declared in favor of the jetties, and although General Wright gave the preference to the canal, it was not because he believed the jetty system impractical, but because he believed the other the more certain of the two; and I believe none of the other three officers are more rejoiced at the success which has attended the jetties than he is, because a great question in river hydraulics has been settled with advantage to the nation. While these officers, who were appointed by the President upon the board, gave their judgment in favor of the jetties, the chief of the corps, who controls its operations and thus fixes its standard of value in the public estimation, continued, even after the law was passed, to publish, at the expense of the Government, erroneous arguments calculated to lessen the value of the conclusions of the commission and to create public distrust in the efforts of myself and associates, and thus added to the legitimate difficulties surrounding our efforts those of petty official interference. It is wrong and unfair to charge me with making war upon the engineer corps when so many of its members, by their virtues, their talents, and their patriotism, command my respect, and are deserving of that of their country.

Craving your pardon for occupying your attention so long with this personal explanation, I will proceed to explain some of the phenomena of the river.

The speaker then referred to the diagrams illustrating his remarks, and called attention to the fact that the surface slope of the river in flood time increases gradually as we ascend the river from the head of the passes, being less than an inch and a half per mile below New Orleans, and only one and seven eighths of an inch at Red River, while in the next sixty miles it rises to nearly three and a quarter inches, or nearly double the grade. This rapid increase becomes still greater as we proceed on up, until at Cairo it exceeds five inches per mile, and is over six at St. Louis. He said:

Particular attention is called to this question of flood slope, for this is really the levee question. If the slope were steeper, the levees would have to be higher, because they must be above this slope to prevent overflows. Hence everything tending to alter the slope of the river should be one of deep interest to those who are directly interested in the levees.

The current is the result of the fall of the water from a higher to a lower level, and the inclination of slope of course indicates the force which the water is exerting. Now, the steeper the slope, the more rapid we ought to expect the current to be, but we find there is really but little difference between its average velocity here, where the slope is least, and at Cairo, where it is so great.

The current is retarded by several causes, but the grand and chief one, and the only one we need to consider tonight, is that of the friction of the water in passing through its bed. The ratio of friction rapidly increases as the volume or quantity of water flowing is reduced, because then the proportion of water in contact with the surface is greater. This may be illustrated by supposing two water pipes, one of one foot and the other two feet diameter. The circumference of the large pipe being twice as great as the other, the water in it will have twice the friction of the small one, if both be placed at the same inclination, but we will find that the water in the large one flows much more rapidly than in the other, because while the friction is only doubled by the diameter, the volume has been quadrupled, so that the water in it has really only half as much friction to retard it as that in the small one. Hence if we want the same velocity in the small one, we must give it a steeper slope, or greater head. The river does this, and we must naturally expect its slope to steepen as we proceed up stream, because the volume is diminished above each tributary, and because of the laws which control falling bodies. But we find that this does not account for the enormous increase above Red River, and hence we must look for another cause for it. As it is the surface of bed in contact with the water which creates the friction, it follows that if the bed be narrow and deep the friction will be much less than if the width be great; and if, as is the case in many places, the width be four or five times greater than at others, we must expect steeper slopes than where it flows in the narrow channels. Above Red River up to Cairo and above there we find there is one continued succession of wide places. Islands also increase the slope, just as we should have to increase the slope of the water in our two-foot pipe if we divided it into two streams as an island divides the volume of the river; and here the islands are numerous.

We know that the channel of the river from Red River to Cairo is continually shifting, and that violent changes are made in its location by cut-offs, so that these slopes must be also suddenly altered. Then why is it that the average rate of current is restored despite these changes?

This inquiry brings us to another part of our subject, and when you fully understand it you will see that nature has endowed the river with something wonderfully resembling the instinct of self-preservation that is common to the whole animal kingdom.

The adjustment of slope so as to regulate the current results from the sediment-bearing quality possessed by all water when in motion. The great mass of earthy matter continually carried by the river to the sea is borne in suspension by the water, and the quantity with which the river is charged is determined by the velocity. If this be reduced, a portion of the sediment falls. If it be stopped, and the water be still, all of it falls to the bottom. If the bottom be of sedimentary matter that has not been changed by time into stone, then an acceleration of current at any place will cause the water to take up from the bed such additional quantity of sediment as may be due to an increase of velocity.

The river is flowing over a bed of its own deposits from Cairo to the sea, and sediment thrown down in it yesterday, or a thousand years ago, is readily taken up again to-day if the current be accelerated over it. This fact is proven by every cut-off that has ever been made on the river.

A little thought teaches that the quantity of sediment annually discharged into the Gulf and over the banks of the river, through any long period of years, must be very nearly equal to the quantity discharged into it by its tributaries; for if it were less, the bed would be built up and elevated by the quantity left in it, and the slopes steepened, and if it were more the bed would be deepened, the slope lowered, and the current finally destroyed. We may then properly call that rate of current the normal one which carries the sediment without loss or gain. If from any cause, a cut-off for instance, the normal velocity be disturbed, the river at once goes to work to restore the disturbance in the current. Above the cut-off the current has been suddenly accelerated and rushes rapidly through the new channel, and gathers up from its bed in and above the cut the extra amount of sediment due to this increased velocity, while below the cut the opposite conditions exist. The surface there is quickly raised by the rapid drain going on above; the current is then less rapid than before, and the excess of sediment falls to the bottom, and these effects are produced up and down below the cut as far as the disturbance is felt.

If a flood occurs the water acquires a high velocity in the narrow parts of the river, and a corresponding quantity of sediment. This current cannot be maintained through the wide places, and therefore the sediment falls in the bed in them until the bottom is raised and a steeper slope and higher velocity are created in the effort of the river to maintain the normal velocity, which is that rate that will discharge all the sediment poured in by the tributaries, without gain or loss. But when the flood falls we find these wide places filled up with deposits and covered with sunken stumps and logs, through which the low water channels are cut.

Evidently, then, a uniformity of width must produce a uniformity of depth, and this in turn insures a uniformity of velocity. This insures a uniform charge of sediment, and as the tributaries determine the quantity, and a given velocity will only sustain a proportionate quantity of sediment, it is plain that there will be little or no depositing or deepening of the bed. This explains why below Red River caving banks occur to such a limited extent, and why they are so devastating above. Bring the high water channel to an approximate uniformity of width and the caving of the banks will be reduced to insignificant proportions.

You will now comprehend why the levee system must ultimately be abandoned, simply because it requires these wide places, the fruitful and only cause of caving banks and cut-offs, to be inclosed within the levees, and hence the caving and the cut-offs must continue and the destruction of the levees must follow. You will ask, Why cannot the caving be prevented by rip-rap or mattressing the banks? The answer is: This may be done on the Po, the Rhine, or the Wabash, at some moderate cost, but the Mississippi is too vast in its volume to admit of it with any amount that would be voted by Congress as a palliative measure. You would have to stop the excavations of the river where its forces are working a hundred feet beneath the surface.

Narrowing the wide places is a thing much easier accomplished, because it needs no work done except in shoal water. Where it is deep it is already narrow.

The steep flood slopes which we find even in the narrow parts of the river above Red River, and in the Atchafalaya Pass and in every outlet and bayou of the river, and in the island chutes, should teach any thoughtful person, it seems to me, that one universal law controls the channels in the alluvial district, which law demands that where the volume is reduced the slope must be steepened, and therefore if we would lower the levees we must not lessen the volume. I am satisfied that if the volume below Red River were increased, as it would be by closing Atchafalaya and compelling Red River to seek the sea by way of your city, it would lower the flood line five or six feet at the mouth of Red River and more than two feet at New Orleans.

The same reasoning assures me that closing all gaps and crevasses in the levees and thus increasing the volume in the natural channel will not necessitate higher levees, and hence the estimate of $46,000,000 is very excessive and unreliable, because it is based on the idea of raising them from three to eleven feet higher than before the war. The great objection to the levee system is not from the present amount needed for absolute protection from the near floods, because four or five million dollars would insure this; but it is the incessant destruction of them which must ensue from the cause I have named. Remove that cause and the levees can be cheaply maintained, but when the cause of the caving banks is removed we will find the flood slope lowered and levees useless.

It will be seen that this system is radically different from that advocated by the Levee Commission, by Humphreys, Abbot, Warren, Hebert, and engineers of lesser fame, who adopt the theory that there is no relation between the velocity of current and amount of sediment carried; because they have invariably compared the velocity per second with the sediment contained in a cubic foot of water, and not with the total amount carried by the whole river in each respective second of time that the velocity is noted.

They advocate the diffusion of water by outlets and raising high levees around the wide places. I advocate its conservation, every drop of it, in one channel of uniform width, and the abolition of all the wide places; the closure of the outlets, every one of them, and, if found necessary, the closure of the island chutes. They propose to attack the banks of the river with shovel and wheelbarrow, to accommodate its anticipated elevation ten or a dozen feet higher than ever before. I propose to set the river to work in the bottom of its bed, as we did at the jetties, and, while deepening it for the benefit of commerce, lower its haughty crest forever. They provide for a river carried threateningly above the land, a constant source of terror and anxiety, while I propose that its vast volume, in all the grandeur of its mightiest floods, shall be viewed with an admiration devoid of fear, from happy homes safe above its surface.

PROGRESS OF LUMBER FLUMES.

THE first record of a flume being used for the transportation of wood or lumber occurred in Washington Territory—from the forests bordering on Puget Sound to tide water. A flume was next constructed in Nevada for the purpose of supplying Virginia City with cord wood. This flume extended from the eastern slope of the Sierra to a dump near Carson City. The Antelope Flume was, however, the first one built in California for lumber purposes. The construction of this flume was followed the next year by the Blue Ridge Company bringing lumber from the mountains near the dividing line in Tehama and Shasta counties to a point 12 miles north of Red Bluff on the Sacramento river, and this flume has since been continued to Red Bluff by the Sierra Company, and by a flume built by the Butte Lumber Company extending a distance of 35 miles from the forests in the southeast of Tehama, where that county intersects Butte, to three miles east of Chico. For several reasons, mainly because of the large amount of capital necessary to be invested to successfully carry on enterprises of this character, these several projects were not so remunerative as the promoters desired.

The flumes are generally constructed of lumber planking, 30 inches wide and 16 feet long. These are nailed together at the side, making a V-shaped trough or box. They are then fixed in brackets, thus forming a continuous channel for the passage of the water, which is let into the flume from a diverted mountain stream. In the flumes constructed two or three years ago but two brackets were used to a box. In some of those of the Sierra Flume and Lumber Company three are used, thus adding to the strength of the flume. The rapidity with which the lumber is transported varies of course with the fall. With a down grade of one inch to the box (16 feet), or 27 feet to the mile, the lumber travels from two to three miles per hour. With a grade of two inches to the box, or 55 feet to the mile, the rate is about trebled, and the increased velocity is in a similar ratio where the grade is augmented. Thus a grade of five or six inches to the box insures a velocity of from 18 to 20 miles per hour. On the Blue Ridge division, the 30 miles from the mountains to the dump on the Sacramento river are made in about three and a half hours. On the Chico branch, lumber put in at the Arcade Mills reaches Chico, a distance of 40 miles, in less than four hours. Of course it is necessary to have men constantly engaged in watching the flume to prevent the lumber from bunching, as it is called. For this purpose a plank walk is constructed its entire length.

The Sierra Flume and Lumber Company are now operating 150 miles of V-flume for lumber transportation—one flume on Chico creek, terminating at the town of Chico; one on Antelope creek, terminating at Sesma; and one on the waters of Battle creek, terminating at Red Bluff. On these flumes are in operation ten saw mills, with a continual capacity of over 300,000 feet daily, and an annual capacity of 50,000,000 feet. The Chico Flume is 45 miles long, and carries lumber right into the yard at Chico. They can bring down 100,000 feet per day. If the lumber is placed in the flume at three o'clock, the last of it will be in Chico at six or half-past six o'clock. It costs 70 to 80 cents a thousand to ship the lumber in this way, whereas in the old way of hauling by teams it cost about $10 a thousand to get it down the mountains.

These flumes are very expensive in some places, and skillful engineering is required to build them. In some places the trestle work upon which they are supported is 100 or 150 feet high. The Ink's creek crossing is 110 feet high and a third of a mile in length, with an arch in the center. The flumes cost from $1,000 to $2,500 a mile to build, and in places where high trestle work has to be constructed the cost is increased.

The water to supply these flumes is no small item. It is collected from various springs and streams in the mountains, and run in feeders to the flumes. It takes a great deal of water to run the flumes, so they are kept busy while the water season lasts.

From Blue Ridge division there are at present two flumes, each 12 miles in length, running respectively from the Clipper and Defiance Mills to a point called the Junction. At this point the two unite and form one flume, which extends a distance of 32 miles to the yards at Red Bluff. This piece of fluming is perhaps the finest piece of workmanship of this character yet attempted. It starts out with 2,100 feet of trestle work, from 60 to 120 feet high, over a ravine called Ink's creek, followed by 1,800 feet more over another known as Sharp's Flat, of an average height of 60 feet. There has also just been completed three and a half miles of new flume, connecting the Moscow Mill with the Defiance Flume, and seven miles more will shortly be commenced, by which advantage can be taken of the cheap transportation furnished by this means for forwarding lumber made at the Eureka Mill. During the past season the average expense of fluming lumber on the Chico division over about 40 miles of flume was about 60 cents per 1,000 feet. On the Sesma division there are 50 miles of flume in operation, and on the Chico 40 miles.

This trestle work has to be made very strong, braced and guyed in every direction, as the winds in the mountains are at times very high, and if the trestle work was not properly made the whole structure would come down. In some of the canyons the flume has to be fastened to the side of a perpendicular wall, where one would hardly suppose any work could be done. In some places the trestle has to be bolted and chained to the rock in the firmest manner.

The Moscow Mill, the largest one belonging to the company, is a steam mill, and is 45 miles from Red Bluff, in that division. This mill has a capacity for sawing 40,000 feet of lumber a day, and is one of the most complete on the Pacific coast. All the recent improvements in this class of machinery have been introduced. The tremendous logs are cut up and made into lumber ready for piling away with astonishing rapidity. Besides the large circular saws, gang-edgers, etc., there are cut-off saws and implements to utilize and trim the pieces cut off from the larger boards, as they come from the circular saws, such as are not considered marketable. The lumber from this mill comes into Red Bluff. The mill is situated at an elevation of from 4,000 to 5,000 feet.—*Min. and Sci. Press.*

CHIMNEY CONSTRUCTION.

AT a recent meeting of the Civil and Mechanical Engineers' Society, London, Mr. J. M. Bancroft read a paper, of which the following is an abstract, on "Chimney Construction."

I find, upon reference to the various authorities who have written about chimney construction, that there is a wide difference of opinion as to the proper dimensions they should be made.

Mr. Robert Armstrong, in the appendix to his "Chimneys, Furnaces, and Fireplaces," published by Spon (1866), page 63, says: "It may be set down as an axiom that *a steam-engine chimney cannot be too large*, if only provided with a damper, although ninety-nine in one hundred at the present time (1866) are decidedly too small. They are unable to create a sufficient draught of air through the furnace, consequently a *smoky flame* is produced, instead of a flame with little or no smoke."

Against Mr. Armstrong's opinion we learn from Mr. Peter Carmichael, in his paper on "Factory Chimneys," read before the Institution of Engineers in Scotland, 1865, that his "experience is that most factory chimneys are too large for the work they have to do; not too high (they can hardly be that), but too wide, especially at the top. In our practice (Messrs. Baxter Brothers, flax mills, Dundee), invariably as more boilers and furnaces have been added to a chimney the draught has been improved; and it is obvious that if the opening in the chimney be too large compared with the whole of the openings in the dampers passing into it the draught will be reduced. Hence it is very noticeable in many chimneys, which are too large in proportion to the number of furnaces they serve, or the coals consumed, or when a new chimney is put up to serve for prospective additional furnaces, that the smoke issuing from such has a very lazy ascent, and they are generally blackened a long way down from the top by the smoke, for when a breeze is blowing, the smoke, instead of ascending, falls down the leeward side of the chimney and clings to it like a ragged black flag."

Mr. Robert Wilson, in his "Boiler and Factory Chimneys," published by Crosby, Lockwood & Co., 1877, cautions us against too large a flue. He says: "It is usually considered that the larger the area of the chimney the better the draught, but this is not always the case with lofty chimneys where the gases can *cool down too rapidly* in a chimney of large section, and it has been found in several instances that when chimneys are very large for the number of boilers they serve, or for the quantity of coals burnt, as when a chimney is built to serve for future additions to the boiler power, the draught is improved by the better maintenance of temperature as additional boilers are set to work [thus agreeing almost word for word with Mr. Peter Carmichael]. When the area of the chimney is much larger than the aggregate area of the flues debouching upon it, the diminution of friction and the expansion of the hot gases into a large area are favorable for the improvement of the draught. But the velocity of the ascent of the heated gases may be very much diminished, and in extreme cases, where the ascending current does not fill the chimney, so to speak, downward currents of air will be produced, especially with the wind in certain directions, to the impairment of the draught."

TEMPERATURE OF ESCAPING GASES.

Mr. Peter Carmichael recorded observations made from time to time for several years on the temperature of the escaping products of combustion in the flues and at the bottom of the chimneys, and also took notes of the force of the draught, both of which are important elements in considering the value of a chimney for doing its work properly, and he gives the results as follows:

"The temperature is obtained by using small strips of the following metals: Zinc, which melts at 700°; lead, 600°; bismuth, 500°; and tin, 440°. Small bits of each of these, about 1 inch long and ½ inch broad, are pierced with a hole for passing a wire through, and suspended in the flues behind the damper, or at the bottom of the chimney, and the time noted when they are melted. From these observations frequently repeated and tried under various circumstances, it has been found that the temperature is nearly uniform at 600° behind the dampers; 440° melts at once; 500°, generally in less than a minute; 600° melts when the fires are in good condition, and 700° does not melt. So unvarying are these results under different circumstances that I assume 600° at the bottom of our chimneys as a standard of temperature of escaping products."

FOUNDATIONS.

The foundation of a structure bearing a great weight upon a small surface must be carefully attended to. If a good, natural bottom is not to be obtained, an artificial foundation must be made, either by concreting or driving piles; the former is generally sufficient. At the spot upon which the structure is to be raised, the different strata immediately beneath the surface must be examined by boring, until some definite stratum be reached; by a reference to the depth of this bed, some idea of the extent of excavation is arrived at. In all cases the foundation must be equally resistant—that is, all parts of it must be capable of bearing the same amount of pressure; if this be not attended to, unequal settlement is sure to result. In all cases the "made earth" must be removed. If the stratum immediately beneath be of clay, gravel, chalk, or other firm bed, and found to be sufficiently thick for a solid bearing, the excavation may be finished and the foundation laid in. In the neighborhood of London the substratum is generally made earth, beneath which at variable depths, not often exceeding twelve feet, a good bottom is usually met with, when, to save brickwork, concrete may be thrown in, until only enough depth is left from the surface to cover the footings of the chimney.

A good example of the value of concrete is afforded by a chimney that was built by Mr. Clegg, at Fulham, in 1839. The foundation was a quicksand. After the excavation was got out to the depth of 15 feet, an iron rod sank, with little more than its own weight, 15 feet more; it was, in fact, Mr. Clegg says, as bad a foundation as could possibly occur.

TOWNSEND CHIMNEY, PORT DUNDAS.

The highest church spire in Europe is that of St. Nicholas, Hamburg—that of Strasburg 466 ft.—both their heights exceed that of the "Townsend Chimney," Port Dundas, Glasgow; its total height from foundation to top of coping being 468 ft., and from ground level to summit 454 ft. The history of its construction, and of its threatened failure when nearly completed, will therefore be of great interest to all who have made chimney-shafts or stalks their study, and, indeed, to architects and engineers in general. The chimney was designed and built by Mr. Robert Corbett, Bellfield terrace, Duke street, Glasgow, for Mr. Joseph Townsend, Crawford Street Chemical Works, Port Dundas.

No piles were used in the foundation, which is built on "blue till" or clay, which is as solid and compact as rock. The foundation consists of thirty courses of brick on edge, the lowest course being 50 ft. and the topmost course 33 ft. diameter. This foundation was commenced on July 30, 1857, and finished on August 20 of the same year.

The erection of the shaft was continued until November 11, 1857 (excepting from September 3 to October 5, during which period operations were suspended). This closed the first season. The second season commenced on June 10, 1858, and closed on October 16 in the same year, the stalk at the latter date being 298 ft. in height. The third and last season commenced on June 3, 1859, and the coping was laid on October 6 of the same year; but the work was suspended from September 15 to October 5, in consequence of the chimney swaying. During this interval it was restored by twelve cuttings with saws on the opposite side of inclination, as detailed hereafter.

The inside lining or cone is of 9 in. firebrick, and about 60 ft. in height, built distinct from the chimney proper, with air-space between, and covered on top to prevent dust from falling in, but built with open work in the upper four courses, so as to allow of air passing into the chimney.

The size of the bricks used in the construction of this chimney was 10 ft. by 4 ins. by 3½ ins., and the number consumed was as follows:

Common bricks in chimney.....	1,142,532
Composition and firebricks in cone.....	157,468
Total	1,300,000

The bricklayers' time was

In 1857, 316	days, of 10 hours each,		
" 1858, 431½	"	"	"
" 1859, 423½	"	"	"

giving a total of 1,171 days' time occupied in building the chimney, which gives on an average 1,110 bricks built per day of ten hours by each bricklayer.

Besides the above number of bricks used in the chimney, there were also 100,000 used in constructing flues, etc. The total number of bricks laid in chimney and flues was 1,400,000, the weight of which, at 5 tons per thousand, is 7,000 tons.

The cope is of vitrified till, purpose-made, about 9 ins. wide × 3 ins. thick, flanged over wall of chimney, and jointed with Portland cement.

The top of the chimney was struck by lightning some time since, which displaced and threw to the ground some pieces of coping, and upon inspection only one of the flanges was found to be broken.

Iron hoops were built in at a distance from the surface of 9 ins. at the bottom and 4½ ins. at the top, and at intervals of 25 ft. in height.

The thickness of the wall of the chimney varies as follows, commencing, of course, at the ground level:

1st	section,	30 ft.	in height,	5 ft. 7 ins.	thick.
2d	"	30	"	5 2	"
3d	"	30	"	4 10	"
4th	"	40	"	4 5	"
5th	"	40	"	4 0	"
6th	"	40	"	3 7	"
7th	"	40	"	3 2	"
8th	"	40	"	2 9	"
9th	"	40	"	2 4	"
10th	"	52	"	1 11	"
11th	"	52	"	1 7	"
12th	"	20	"	1 2	"

Total, 454 ft. from ground line.

The height originally contemplated for the chimney was 450 ft.; but when about 350 ft. up it was proposed to add about 35 ft. to the original height, making the total height 485 ft.: hence the increased height of the tenth and eleventh sections. But on the completion of the eleventh section this idea was abandoned, and therefore only 20 ft. of the last thickness were added.

The chimney was not built by contract, but by day wages, as Mr. Townsend was not quite certain to what height he would carry it, or what deviation might be made in course of construction from the proposed plan. Three different dimensions were calculated by the builder; those carried out were the greatest of the three. The builder calculates the cost of the chimney and cone (exclusive of iron hoops in chimney and flues) at from £5,500 to £6,000. Mr. Townsend estimates the cost of the whole, including flues, iron hoops, machinery, and scaffolding, at £8,000.

On September 9, 1859, the chimney was struck by a gale from the northeast, which caused it to sway; but the builder does not attribute the action to the gale alone, but to the pressure of the whole pile on the scaffolding, which was so constructed as not to yield to any pressure caused by a slight settling-down. The additional pressure thrown by the wind to the lee-side of stalk (the mortar of which was not solidified) was consequently too great for the scaffolding to bear, and caused the splice of one of the uprights to give way by abrasion, making the fibers of the wood to work in each other. The ends of the planks forming the scaffolding were placed about 5 ft. or 6 ft. apart vertically, and were tightly built into the masonry; but had a little space been left over each the stalk would have subsided uniformly, and would possibly have withstood the gale. The builder observed the error, but too late. He thinks the deflection commenced at from 100 ft. to 150 ft. from the ground, so that the foundation and heaviest portion remained firm. Had not the process of sawing been commenced promptly and continued vigorously, in all likelihood the chimney would have fallen. Even during the earlier part of the process of sawing, Mr. Townsend, who was on the ground the whole time, observed the deflection increasing, but as the sawing progressed he observed that the deflection got a check, and the chimney came to gradually. The chimney was 7 ft. 9 ins. off the perpendicular, and several feet less in height than before it swayed; but when brought back it gained its original height, at which time it was not completed by 5 ft.

Mr. Townsend made his observations during the sawing-back by taking up his position in a room of the works near by the chimney where he had a full view of it, and, fixing the ends of two pieces of twine to a beam above, he formed them into two plummet-lines in a line with the stalk, and with these alone he directed the adjustment of the colossal mass.

The sawing-back was performed by Mr. Townsend's own men, ten men working in relays, four at a time sawing and two pouring water on the saws. This work was done from the inside on the original scaffolding, which, of course, had not been removed. Holes were first punched through the sides to admit the saws, which were wrought alternately in each direction at the same joint on the opposite inclination, so that the chimney was brought back in a slightly oscillating manner. This was done at twelve different heights from the ground line, viz., 41 ft., 81 ft., 121 ft., 151 ft., 171 ft., 189 ft., 209 ft., 228 ft., 240 ft., 255 ft., 277 ft., and 326 ft. The men discovered when they were gaining by the saws getting tightened with the superincumbent weight. It took six men to do this work, at a cost of £400.

Prior to the sawing operations they had taken out and altered the bolts of the scaffolding, so as to relieve the pressure on it. This was done to meet the want of a little spare space over the ends of the planks built into the chimney, as before stated.

PROTECTION FROM LIGHTNING.

From inquiries I made, Mr. Townsend says: "Our stack is protected from lightning by two copper wire conductors, half an inch thick, opposite each other all the way up, joined to one pike fixed to the chimney, but standing above it, at the top. It was erected by a Steeple Jack of Manchester, immediately after the chimney had been put straight about 1859 or beginning of 1860. The chimney has been several times struck by lightning and slightly damaged. It is intended to put three more pikes at the top and take the conductor round the chimney from pike to pike, to give a better opportunity for absorption of the electric fluid."

ST. ROLLOX CHEMICAL WORKS CHIMNEY, GLASGOW.

Messrs. Charles Tennant & Co.'s chimney, projected by the late W. J. Macquorn Rankine, C. B., LL.D., designed by L. D. B. Gordon, and built by the late Mr. McIntyre, ranks second in height, being in—

	ft.	ins.
Height from foundation to top.....	455	6
" " ground surface to top.....	436	6
Outside diameter at foundation...	50	0
" " ground surface....	40	0
" " top.....	13	6

It has an inner cone of the following dimensions:

	ft.	ins.
Height of inner cone from foundation to top....	263	0
" " " " ground surface to top.	243	0
Inner cone inside diameter at foundation.....	12	0
" " " " top....	13	6

The use of the inner cone is to protect the principal stalk from various kinds of gases.

No piles were driven in the foundation, it being founded on a bed of concrete 15 ft. thick on top of the rock, the upper surface of the concrete, the better to resist any downward pressure, being finished at right angles to the line of principal shaft, which inclines inward for a considerable height.

The outline of chimney, it may be said, is taken from the Eddystone lighthouse, or the natural form which a chain would assume in being stretched from a height to a point on the ground beyond that of its upper end.

The highest chimney stack in England is the

LARGE CHIMNEY STACK OF MESSRS. DOBSON & BARLOW, KAY STREET MACHINE WORKS, BOLTON, LANCASHIRE.

The large chimney stack, connected with seven boilers, ventilating flues, furnaces, etc., at these works, was completed in November, 1842, and was then intended to serve a chemical works. Shortly after, the ground occupied by the chemical works was included in Messrs. Dobson & Barlow's works, and consequently the chimney came into their possession.

The following are some principal particulars:

Total height from ground level, 367 ft. 6 ins.

Octagonal in plan, 14' 0" on every side, or 112 ft. girth at bottom.

Thickness of brickwork at bottom, 8 ft.

Thickness of brickwork at top, 1 ft. 6 ins.

5' 6" on every side, or 44' 0" girth at top.

800,000 bricks and 120 tons of stone work were consumed in the building. The top, with cornices and mouldings, required 30 tons of stone and cement.

EDINBURGH GAS WORKS CHIMNEY.

	ft.	ins.	
This chimney is	341	6	from foundation to top.
"	329	0	" ground "
Stone foundation,	40	6	square and 6½ ft. deep.
" pedestal,	71	0	high.
" "	30	0	square at ground line.
" "	27	9	" top.
Brick shaft,	264	0	high.
" "	26	3	diameter at bottom.
" "	15	0	" top.

The main brick shaft is diminished in five steps of the following successive heights:

	ft.	ins.
1st bottom portion.....	35	35
2d portion	40	30
3d "	48	25
4th "	58	20
5th "	83	15

An inner chimney of brickwork, 90 ft. high × 13 ft.

The next chimney that I shall notice is the one at Barmen—the interest attaching to this is another example of straightening when out of perpendicular.

MESSRS. WESENFIELD & CO.'S CHIMNEY, CHEMICAL FACTORY, BARMEN, PRUSSIA.

This chimney is 343 ft. from foundation to top.
" 331 " ground "

The foundation was made of large flat quarry stones with terrace mortar: 1 lime, 1 river sand, 1 terrace, which latter is a kind of pozzuolana.

20 ft. square pedestal by 40 ft. high by 7 bricks thick.

Octagonal shaft 291 ft. high.

Octagonal shaft, exterior diameter 17 ft. at base by 5 bricks thick; this diameter is reduced 2½ ins. every 10 ft., so that at top of shaft it is 2 bricks thick.

According to the original design, it was intended to only build it 260 ft. high, but as the building was proceeding in a very satisfactory manner, it was considered safe to increase the height without altering the dimensions of the base; and it has been calculated that in the lowest part of the shaft the brickwork sustains a pressure of 21,335 lbs. per square foot, or 148 lbs. per square inch.

The interest attaching to the chimney is that a few months after completion it got out of the straight, and had to be put right in a similar manner to the "Port Dundas" chimney, described at the beginning of my paper.

The chimney was built with great care, the mortar being prepared every morning—the proportions used for the pedestal being 1 lime to 2 of river sand.

Cement mortar was used on rainy days, mixed in the proportions of 1 cement to 2 of river sand, and the crown of the chimney of cement exclusively. The joints of the brickwork were flushed up with cement.

The three masons who did the whole work daily changed their positions on the chimney, so as to equalize any unevenness in the masonry that might be caused by imperceptible differences in the manipulations of the different individuals. At distances of 50 feet single layers of brickwork were painted *black* outside, to afterward facilitate an estimate of the height of any point of the chimney above ground. The chimney was built from the outside without a scaffold, the materials being hoisted by a steam engine put up temporarily near the place of construction. The motion was transmitted by 3 rollers or drums. The frame which supported the upper drum was moved higher up after the completion of every 3 or 4 layers of brick, and was at the same time turned horizontally from one side of the octagon to the next one, to equalize the effect of the pressure of the frame on the masonry. The holes made in the masonry to support the frame were filled up with brick and mortar immediately after the removal of the frame to a higher level. The construction of the chimney was thus successfully completed in October, 1867, was perfectly vertical, and answered the requirements for which it was erected; and in the spring of 1868, remarkable for vehement and long-continued gales and storms, this chimney suddenly assumed an inclined position toward the northeast. The injurious action of the southwest wind was probably favored by the bold proportions of the structure, by the yet subsisting softness of the mortar, and by the large size and the shape of the ornamented chimney crown. This crown caught the wind and thereby caused it to act as on a long lever. The chimney was thus bent; the mortar not perfectly dry, and the brickwork did not yet possess the necessary elasticity to return to its original shape.

The deflection of the chimney was considered at the end of May, and seemed yet to increase, and threatened an overthrow.

As before mentioned, some layers of bricks in the chimney at distances of fifty feet from each other were painted black outside. The height of these black lines above the pedestal being known, these lines were, by means of a theodolite, projected on a plank situated on the pedestal of the chimney, to find the deviation from the vertical line at these different heights. It was thus ascertained that the chimney, at a height of

251	ft.	was out of line	45 ins.
210	"	" "	30 "
160	"	" "	16 "
110	"	" "	5 "

The pedestal stood perpendicular. As the deviation was still increasing, and as it would have done too serious an injury to the manufacture of the establishment to set the chimney temporarily out of use, it was necessary that immediate action should be taken in the matter. The ordinary method of straightening chimneys was at first resorted to. A hole was made through the whole thickness of the masonry on that side of the chimney which required lowering, at a distance of four feet above the top of the pedestal. Into this hole a saw was introduced, with which a horizonal cut through one-half of the chimney was attempted. But as the thickness of the wall was considerable and the bricks hard, and as the saw could be manipulated from one of its extremities only, the effect of sawing after two hours' work was scarcely perceptible.

The hole through the chimney having been made without trouble, the difficulty experienced in sawing led to the idea to gradually remove a whole layer of bricks, replacing it by a thinner layer, thus to produce the desired slit. Before, however, this operation was performed, the experiment was made with an old inclined chimney, 120 feet high. When the method had there proved practicable and successful, it was concluded to treat the new chimney in the same way.

A layer of bricks was broken out by means of pointed cast-steel bars from one and a half to five feet in length.

Purpose-made flat shovels, with long handles, were used to lay those bricks which had to be placed near the inside of the chimney. A space of 5 ins. was left each time between the newly-laid bricks and the old ones of the next division, to break out the latter with greater facility.

The width of each single division was two feet to two and a half feet. The masonry was sufficiently dry above not to give way when a layer of that width was removed below it.

The act of settling by oscillations lasted from 18 to 36 hours, corresponding to the width of the slit, which was different in the different cuts, performed in a similar way at different heights of the same chimney. The oscillations were the greater and the livelier the higher up the cut was which produced them.

At the highest cut, 100 feet from the top, the oscillations were such that the mason became frightened and left the place; the slit became alternately wider and narrower by three-quarters of an inch. The facts before mentioned seem to prove the elasticity of the whole structure. Four cuts were made into this chimney; the

1st	4 ft.	above the pedestal,	greatest width	.....	¾
2d	100 "	"	"	.....	1¾
3d	140 "	"	"	.....	1½
4th	191 "	"	"	.....	1

After the completion of these operations the chimney continued during several weeks to settle slightly in the direction opposite to its former inclination, the brickwork on that side being now subjected to a higher pressure than before.

This circumstance has to be carefully considered beforehand, or else the slits would be made too wide, and produce an inclination of the chimney in the opposite direction. A severe storm which occurred on the 6th and 7th of December, 1868, and which threw over several chimneys in the neighborhood, did not affect the above. The result of the straightening operation, before described, is perfectly satisfactory, and the structure is now stronger and steadier than ever.

I have yet to speak of the means by which the upper parts of the chimney were made accessible to perform the upper cuts. This was done on a new and interesting plan. Standing on the lowest platform, the masons made a number of holes all on the same level, 4 ft. above the platform, into the exterior wall of the chimney. They stuck iron bars into these holes, and fixed boards to them, so as to form another platform. Standing then on the latter, they made another one 4 ft. higher up in the same way, and so forth. Every second platform was again removed, so that the remaining platforms were 8 ft. apart.

They were then joined by ladders to make the ascent possible and easy. This method is, however, only practicable when the chimney has a considerable diameter, and when the mortar is sufficiently dry not to give way under the one-side pressure of the bars and platforms, which would make the arrangement loose and unsafe.

In December, 1868, another chimney at Duisburg was straightened by the method above described.

But as the diameter of the chimney was not as large as that of the Barmen chimney, and as the mortar was yet soft, a wooden scaffold was erected around the chimney, to get at the upper points which required cutting. The breaking out and replacing of the bricks could not be done there in divisions wider than 5 to 10 inches, otherwise the upper masonry, not being dry, would have settled down. When the chimney was straight, a further settling toward the side of the cut was prevented by driving iron wedges covered with mortar into the slit.

It is needless to add that great care must be used in the method of straightening chimneys here described, for without precaution it may end in a fatal manner, as recorded further on in a case at Oldham, where, owing to the reckless manner in which it was done, one man lost his life.

MESSRS. EDWARD BROOKS & SONS' CHIMNEY FIRE-CLAY WORKS, HUDDERSFIELD.

The shaft is built entirely of fire-clay.
It is 330 feet high from foundation to top.
315 " ground "
Concrete foundation.
Ragstone footings 36 feet square at base.
" 31 " ground.
Brick shaft 27 feet outside diameter at ground.
" 15 " inside " "
" 13 " outside " top.
" 9 " inside " "

The chimney contains the following weights:

144 cubic yards concrete.
2452 " feet ragstone footings.
3341 " " ashlar.
2227 " yards brickwork.

The cap being so large, and overhanging so much, has cost the firm at least £700. In the first instance the covering blew down; it was entirely removed and covered flat with lead, which also blew off, and all had to be taken down. Then the action of the acids emitted from the chimney decayed the stone; one of the overlapping stones fell off; Messrs. Brooks then removed all down to E, and rebuilt the top to its original height or point.

The firm, from their experience, have arrived at the conviction that chimneys should be built with one regular batter from bottom to top, and no stone should be used at top, any overlapping to be gradually formed by hard-burnt radiated fire-bricks 14 ins. by 5 ins. by 3 ins.

CHIMNEY AT MESSRS. MITCHELL BROTHERS', MANCHESTER ROAD, BRADFORD.

This stone chimney is octagonal.
Height from foundation to top 330 feet.
" ground " 300 "
Flue perpendicular 7·0 dia.
The foundation consists of
1 course of concrete 22 ft. × 22 ft. × 1 ft.
1 " " 21 ft. × 21 ft. × 1 ft.
The stack itself measures
30 ft. across foundation.
9 ft. at summit.

The architect who designed the shaft was Mr. Mark Brayshaw, and the builders Messrs. John Moulson & Son.

CIRCULAR CHIMNEY STACK, ADAMS' SOAP WORKS, SMETHWICK, NEAR BIRMINGHAM.

	ft.	ins.
Height from bottom of foundation to top.	326	10
Height from ground surface to top.....	312	0
Outside diameter at ground surface.....	27	2
Inside " " "	15	5
Outside " at top	5	6
Inside " "	4	0
	tons.	
Weight of brickwork.....	2000	
" concrete, sand, and lime.....	150	

This chimney was built in 1835, and at the time of its erection it was the highest in the kingdom. The builder who began the stack felt alarmed when about half way through his work, and the firm had to finish it themselves.

It has been five times struck by lightning, once during the building and four times since. No very serious damage was done to it by the electric fluid but once, when perhaps from the same cause, and the abstraction of the lime by hydrochloric acid from the mortar, the owner was compelled to take down a portion of the top. A few years ago about thirty feet more were removed by a Mr. Frith, builder, of Coventry, by means of a kite, without stopping the works. The total height is now about 250 feet.

CHIMNEY AT MESSRS. COX BROTHERS', CAMPERDOWN LINEN WORKS, LOCHEE, DUNDEE.

The form of the chimney is square up to the height of 230 feet, where there is a balcony or cornice, and from this to the top the form is octagonal, and finished with a heavy moulded coping.

It is built in different panels, and ornamented by various designs in party-colored bricks. The base in outward appearance is of ashlar, and surmounted by a massive moulding in stone. Above this is the first panel, the styles or pilasters of which are checkered red and white; above this is a base moulding, out of which spring the styles of the next or main panel forming the shaft of the tower, and is 137 feet high. It is relieved by loop holes in the center and sham clock holes at the top, the styles being striped red and white; the top of the panel is rounded or arched, and above it two smaller panels, surmounted by a Grecian frieze and other ornaments in white and black bricks; over this is the cornice or balcony, with a square turret at each corner, between which is an ornamental railing. There is access to the balcony by means of an iron ladder, built into one of the corners, the outside walls being square, while the smoke shaft, or flue, is round, thus leaving an empty space in each corner, one of which has been used for this purpose.

The smoke is admitted into the chimney by elliptical openings 9′ 6″ by 5′ 6″ in each of the four sides, but only two are yet in use.

At present there are 58 furnaces connected to the chimney, and also the smoke from 13 forges in smith's shop, besides using the draught for some other purposes.

The strength of the draught at present is equal to 1·8 inch, which goes to prove that the chimney would be able for double the work it is doing now.

The following are some of the principal dimensions:

Foundations 35′ 0″ square, walls 12′ 0″ thick.
At surface of ground 30′ 0″ square, walls 6′ 0″ thick.
At top of 1st panel 24′ 0″ square, walls 3′ 3″ thick.
At top of main panel 21′ 3″ square, walls 2′ 5″ thick.
At the top of balcony 20′ 3″ square, walls 2′ 0½″ thick.
At the top of chimney 19′ 0″ square, wall 1′ 6″ thick.
Diameter of smoke shaft at bottom 14′ 6″, walls 18″.
Diameter of smoke shaft at top 13′ 8″, walls 9″.
Height from foundation 290′ 0″.
Height from surface of ground, 282′ 0″.

This chimney was designed by Mr. James Maclaren, for Messrs. Cox Brothers, Camperdown Linen Works.

PREVENTING HONEYCOMBS IN CASTINGS.

THE annoyance and inconvenience caused by blow-holes or honeycombing in castings made from molten wrought-iron, steel, or other metals, are well known; and with a view to prevent them, and thus insure soundness in the casting, an invention has been patented by Mr. John Bourne, C. E., of Mark lane, according to which he extracts from the metal while in the molten state the gas or gases by which the honeycombing is produced. The removal of the gases may be effected by the aid of any mechanical means capable of producing rarefaction, such as a common pump, an exhausting jet of steam or other fluid, the hydrostatic gravitation of a column of the molten metal itself, or any other exhausting expedient by which a vacuum more or less perfect is produced. The molten metal must be exposed to the action of the vacuum in such a manner as to insure the disengagement of the gas from the metal, and for this purpose he submits the metal to the vacuum preferably in a state of minute subdivision. This may be accomplished by allowing the molten metal to run through perforations in a fire-clay block into a tall cylinder, within which a vacuum is maintained. By thus subdividing the metal, and discharging it in the form of a metallic rain into an exhaust chamber, the gases are separated from the metal, and are sucked away by the pump or other extractor in communication with the exhaust chamber. He remarks that it is not intended to subdivide the molten metal (without the aid of a vacuum) for the removal of the gases, nor to attempt to suck away the gases from a vessel filled with molten metal by producing a vacuum above the metal, as the hydrostatic pressure of the metal itself would under such circumstances retain the gases within the metal, notwithstanding the existence of the vacuum above it; but he extracts the gases by the conjoint action of the vacuum and of the subdivision, as above explained, or by analogous or equivalent means embodying the same conditions.

As a modification of this process he sometimes melts the metal in a crucible provided with a horizontal division plate, having one or more holes therein, through which holes the metal as it melts flows drop by drop into the bottom part of the crucible. He also makes the crucible with a top or cover, which is luted on, and he conducts a pipe from this cover or other convenient part of the crucible to a pump or extractor, by which a vacuum is maintained within the crucible itself. Each successive thin layer of metal as it melts is thus exposed to the action of the vacuum, whereby the gases are sucked away in much the same manner as when the molten metal is poured through a perforated block, as above described. In either case the gas-retaining influence of a column of liquid metal, which produces a hydrostatic pressure within the body of metal itself, is neutralized.

The mould for the reception of the molten metal may, it is obvious, be placed within the vessel in which the vacuum is maintained when that course is convenient, or the metal may be merely cleared of its gases within the exhausted vessel or chamber, and may be conducted thence, while still fluid, into moulds exposed to the atmosphere in the usual manner. Should the metal be cooled too much in the operation of pumping out the gases to retain the necessary fluidity for casting, it may be reheated previous to casting either in vacuo or in the atmosphere by the aid of a suitable crucible. As water in the act of freezing expels the air with which it was charged, and as this air, if rapidly expelled, makes the ice opaque, by reason of the minute air bubbles entangled in its substance, so metals in the act of solidifying tend to expel their gases, and as their solidification is necessarily rapid, a portion of the gases is imprisoned, and honeycombing is naturally produced. He aids the operation of expulsion of the gases during the cooling of the molten metal, for as the metal cools, the gases, besides being expelled, will be pumped away, and cannot, therefore, be reabsorbed.

EXPLOSIONS IN COAL MINES.

A SHORT course of lectures on this subject has been delivered at the Society of Arts by Mr. T. Wills, F. G. S. In the last two lectures reference was made to some considerations connected with safety-lamps, the effect of barometric and thermometric alterations, and the part played by coal dust in explosions. As regards safety-lamps, it has long been known that a strong blast of wind will carry the flame through the gauze and ignite inflammable gas outside the lamp; but it appears only to have been recently made out that a very slight concussion, or even a puff of air, if sufficiently sharp, will have the same effect. This was shown on Monday by firing a mixture of air and gas surrounding a lighted safety-lamp placed at the end of a long tube by the concussion produced by a pistol shot at the other end, a flexible diaphragm being fixed across the tube to prove that the effect resulted merely from a concussion of air. It was remarked on this that the firing of a shot in a mine might readily drive the flame of a lamp at some distance through the gauze, and so ignite the surrounding fire-damp, all the lamps being afterward found uninjured, without anything to show how the accident had been caused. With regard to the photometric value of different lamps, the lecturer stated that some interesting results had been arrived at. With all the English lamps in which glass is used it is found that the mere addition of the glass chimney or cover diminishes the light by about a third, but with the Mueseler or Belgian lamp the arrangements are so contrived that the addition of the chimney increases the combustion in a corresponding degree, and so there is no loss of light at all. On the point of meteorological changes Mr. Wills remarked that many great explosions, such as those

last autumn at Blantyre and Wigan, could be distinctly traced to falls of the barometer, not immediately before, but some day or two before, and he urged that it was not sufficient to consider only changes in the few hours preceding the catastrophe, as had been generally done in such investigations. The effect of a mixture of fine coal dust was shown by a striking experiment, in which a perfectly non-inflammable mixture of air with a small proportion of gas fired immediately when a little fine coal dust was shaken up in the bottle containing it. As in many dry mines this dust exists in large quantities, it was evident that it might often be the cause of otherwise inexplicable explosions.—*Mining Journal.*

MR. STANLEY.

SIR SAMUEL BAKER spoke the truth on Thursday night last in St. James' Hall when he told Mr. Stanley that the Prince of Wales might be regarded as the spokesman of the nation when he addressed the great explorer in warm words of welcome and admiration. Not for many years has there been so much excitement in London as there was on Thursday in connection with the wild rumors on the state of affairs in the East; it seemed as if people could not possibly have a shred of attention to bestow on any other matter, but nearly two hours before the time at which the meeting of the Geographical Society was to commence, the doors of St. James' Hall were besieged by an eager crowd; and many hundreds, if not thousands, had to be left out in the distribution of tickets. The welcome which Mr. Stanley received could not possibly have been more enthusiastic. In view of the many hard words that have been spoken of Mr. Stanley's conduct under certain trying circumstances, the sight on the platform of the stately figure and genial face of the venerable missionary and explorer, Dr. Moffat, father-in-law of Livingstone, was exceedingly gratifying, showing, as we think it did, that so humane and experienced an "African" as he does not consider that Mr. Stanley has greatly sinned.

That Mr. Stanley should be received with all the enthusiasm of hero-worship by the civilized world is just what might have been expected. It is seldom, however, that a hero receives the glory due to his heroism so promptly as Mr. Stanley has done, especially when that glory has been earned in the field of exploration. Hitherto it has only been through the tardy medium of a book that the public at home have learned of an explorer's work; but in Mr. Stanley's case we have been able to watch his progress step by step by means of the eagerly-looked-for letters he sent home from the heart of Africa, like spectators watching the progress of an assault against a hitherto impregnable stronghold. Thus when Stanley emerged once more into "the light of common day," the very first white man at Emboma into whose hands that memorable appeal for help came knew at once that one of the greatest deeds of all time had been accomplished.

The exact grade to be allotted to Mr. Stanley among the *dii majores* of explorers must be left to a future generation, but this we may be sure of, that when the man and his work shall stand clearly out against the "azure of the past," when all the accidental circumstances that accompanied the ever-memorable journey shall have been forgotten, Mr. Stanley will take his place among the foremost of pioneer explorers, as one of the greatest benefactors to humanity and science. He indeed has shown that there is work in the world for many generations of men of science, and it will be long after the region has been opened up to commerce ere science will have obtained an adequate knowledge of its treasures.

Mr. Stanley has been termed "the Bismarck of African exploration;" as Bismarck has united into one great empire the fragmentary states of Germany, so has Stanley by the work he has accomplished united into one great whole the *disjecta membra* of African exploration. But the likeness between the two men extends further than this; in the one case as in the other there has been a well-defined purpose carried out by means of a clear and cool head, firm nerve, unflinching will, and (perhaps more important than all) an iron constitution.

What then has Mr. Stanley done to justify the enthusiasm with which he has been universally received by high and low, by learned and unlearned?

One of the most remarkable characteristics of his work is the unprecedented rapidity with which it was accomplished, considering the rich harvest of results. As he told his followers at Zanibar he meant to do, he shot across the continent like an arrow. In two years and a half, with many zigzags and subsidiary explorations, Africa was crossed from Bagamoyo to the mouth of the Congo. The great work of the expedition, the exploration of the Lualaba from Nyangwe to the sea, occupied only five months; looking at it in all its aspects, no explorer ever did so great a work in anything like the time.

For thousands of years has the Nile been a mystery which civilized humanity has never ceased to seek to penetrate; no other geographical problem, not even the pole itself, has had such a fascination for Europe. Many and many a life has been sacrificed in the attempt to find the source of the sacred stream, and it was in seeking this goal that Livingstone wandered away south to find "the fountains of Herodotus," only to find a grave on the marshy shore of Lake Bangweolo. The glory of virtually settling the problem has remained to Livingstone's discoverer and pupil, Stanley. In his march northward from Ugogo to Lake Victoria Nyanza, the explorer came upon a river which flows into the south of that lake, the River Shimeeyu, about 350 miles long, which may be regarded as one of the most remote, if not the most remote, of the sources of the old Nile. Further, into the west side of the lake flows Speke's Kitangulé river, which Mr. Stanley has rebaptized the Alexandra Nile; this river the latter explored with much thoroughness while staying at the court of the gentle Rumanika. He found it to be a broad lake-river, giving off many lagoons, one of them Speke's Lake Windermere, and having its source in Speke's Lake Akanyaru (now the Alexandra Nyanza), which again has, Mr. Stanley believes, a river of considerable length flowing into its west side, and another coming from the south, having its origin on the east of Lake Tanganyika. Here then, no doubt, we have the ultimate sources of the Nile, which have been sought for since history began. Mr. Stanley, we believe, has virtually set the question at rest, though we are sure he will willingly share the credit of the discovery with Speke, whose geographical instinct was astonishing, and the essential accuracy of whose discoveries has been throughout confirmed by his successor.

For the first time we have, through Mr. Stanley's exploration, an approximately accurate idea of the outline and extent of Lake Victoria Nyanza. Any map of Africa published two years ago shows this lake in a triangular shape, with an offshoot in its north-east corner. Mr. Stanley has broadened it out into an irregular square, with a coast-line of about 1,000 miles in length, studded with islands, many of them inhabited, and its shores peopled by many different tribes.

The geography of the region between Victoria Nyanza and Albert Nyanza may now be plotted with considerable fullness after the work of Mr. Stanley, who, however, was unable to carry out the plan of doing for the Albert what he did for the Victoria. Through one of the valleys which run north and south between the mountains of this region flows another tributary of the Alexandra Nyanza, and on Mount Gambaragara dwell those mysterious fair-skinned people that Speke heard of, but specimens of whom Mr. Stanley actually saw. About the time of Mr. Stanley's visit, we may remind the reader, Signor Gessi explored the Albert Lake, and we believe, to judge from his narrative, was unwittingly driven to its southern shore, about 1° S. lat. Quite recently, as we recorded at the time, Col. Mason has sailed round the lake, and reports it to be comparatively small and land-locked, with no important affluent other than the Victoria Nile.

On Lake Tanganyika Mr. Stanley completed the work of his predecessors. He circumnavigated the lake, and for the first time accurately plotted the outline of its southern part, adding considerably to our knowledge of the people and products of its shores. We have already spoken at some length of his examination of the Lukuga, which Cameron set down on the middle of the western shore as the long-sought-for outlet of the lake. Stanley examined the Lukuga with great care, and concludes that at present it is only a creek, but that as the waters of the lake are encroaching on the shore, either by the rise of the former or subsidence of the latter, the Lukuga will, in a very short time, actually become an outlet. What Mr. Stanley has told us of the lake and the surrounding region is well calculated to whet the curiosity of the geologist and physical geographer. We have already alluded to Mr. Stanley's theory of the past physical history of the region; but even if his knowledge of geology were adequate to the formation of an acceptable theory, he had scarcely time enough to collect the necessary data. Here, at any rate, is a splendid field for the geologist of the future.

Had Mr. Stanley returned home after his exploration of Tanganyika, or had the toss between himself and poor Pocock been "tails to go south" and leave the problem of the Lualaba unsolved, no one would have blamed him, and his work in the Nyanza region would have added very considerably to his previous reputation as an explorer. But his daring dash down the Lualaba is a *coup* that has immortalized him; it has done for him what the publication of "Pickwick" did for Dickens—it has compelled the world to admit that in his own line he is a genius of the first rank. Indeed we cannot but regard the spirit which animated Stanley at this crisis of his journey in Africa as a really heroic one. He himself happily and aptly expressed it in his address at St. James' Hall by quoting the words which Tennyson puts into the mouth of Ulysses, and which he applied to the position of himself and his followers when they were left by their Arab escort on the broad bosom of the Lualaba, at the very gate of the unknown region:

"My mariners,
Souls that have toil'd, and wrought, and thought with me,—
Come, my friends,
'Tis not too late to seek a newer world.
Push off, and sitting well in order smite
The sounding furrows; for my purpose holds
To sail beyond the sunset, and the baths
Of all the western stars, until I die.
It may be that the gulfs will wash us down:
It may be we shall touch the Happy Isles
And see the great Achilles whom we knew.
Though much is taken, much abides; and tho'
We are not now that strength which in old days
Moved earth and heaven; that which we are, we are;
One equal temper of heroic hearts,
Made weak by time and fate, but strong in will
To strive, to seek, to find, and not to yield."

The mouth of the Congo has been known since the Portuguese, in the fifteenth century, began to creep down the African coast, and Tuckey, in the beginning of the present century, traced it about 150 miles to the lower cataracts. Its origin and course was one of the few, probably the greatest of remaining mysteries in geography. Long ago the Pombeiros and other travelers came across streams inland from the Portuguese possessions in south-west Africa, which run northward, and latterly Livingstone made known the great River Lualaba, which, however, against all evidence, he believed to be connected with the Nile. One of the principal streams known, at least since the time of the Pombeiros, is the Casai, a considerable river running northward, and which some geographers maintained must be the upper course of the Congo. Others again maintained, and the reports of the natives seemed to confirm it, that in the region between Nyangwé on the Lualaba and the sea was a great lake into which that and other rivers flowed, while some seemed to think that the Lualaba ran southward, and probably ultimately flowed into Lake Chad. Livingstone, as we have said, thought the Lualaba belonged to the Nile, while Cameron was convinced it was the Upper Congo, but that it flowed almost straight westward. The solution of the problem was a task well calculated to fascinate a man like Stanley, a task in which all his rare qualities as an explorer would be developed to the utmost, but a task for which he has proved himself easily equal. It is difficult, indeed, to see how the work could have been accomplished for generations except by a man of Stanley's character, and by the method adopted by him. In whatever light we regard this part of his recent work in Africa—whether as a mere exploit, or as a vast addition to geographical knowledge, or in the light of the great results that are likely to follow to civilization, commerce, and science—it has scarcely, if ever, been surpassed in the history of geographical exploration. We have in previous numbers shown the magnitude and importance of this discovery. In the course of a few months, by the daring genius of one man, there has been thrown open to our knowledge a river of the first rank, watering a region of apparently exhaustless resources both for the man of science and the trader. It is about 3,000 miles long, has many large tributaries, themselves affording many hundred miles of navigable water; waters a basin of nearly a million square miles, and pours into the sea a volume estimated at 1,800,000 cubic feet per second. Such a piece of work is surely enough to immortalize a man.

Such, briefly, is the work accomplished in so short a space by the Commissioner of the *Telegraph* and the *Herald*, a work which he set about as a mere piece of business in connection with his calling of special correspondent, but for which Mr. Bennett had the insight to see he was unusually well adapted. A private business enterprise has thus accomplished what the much instructed and elaborately equipped expeditions of learned societies have failed to do. It would be a pity were Mr. Stanley's exceptional aptitude for the work of exploration allowed to lie fallow. Even in the basin of the Congo much remains to be done, and we doubt if any great results will follow the Portuguese expedition which Mr. Stanley met at Loanda. There is also South America, the center of which is now more unknown than Central Africa, and which awaits a pioneer like Stanley to show the way to the minute explorer and surveyor. It is stated that Mr. Gordon Bennett contemplates equipping a polar expedition, so that we fear he thinks he has done enough for Africa. But whether or not Mr. Stanley again enters the field as an explorer, he has written his name in indelible letters, alongside that of Livingstone, on the heart of Africa.—*Nature.*

THE INVENTOR OF THE IRISH CAR.*

A BIOGRAPHY of Charles Bianconi, the inventor of the Irish car system, which has now been superseded by railways but which in its time was of great benefit to the country, has been written by his daughter, the widow of Mr. Morgan John O'Connell, for many years member for Kerry. It is in pursuance of a promise given to her father that Mrs. O'Connell has now undertaken a task which, she modestly says, was beyond her powers. She disarms criticism by pleading that she has no pretensions to literary skill, and is only trying to do as well as she can what her father charged her to do. It must be owned that Mrs. O'Connell has no notion of arrangement, and puts her materials together on no sort of plan. In fact, she never tells the story of her father's life at all as a story. Her book is a biography without a biography in it. The reader seldom knows within twenty years where he is in the life of Bianconi. But when this is said, all is said that there is to say in dispraise of Mrs. O'Connell's book. The life of Bianconi might perhaps have been worth writing by any one, or at any rate a short memoir of what he did and how he lived would have been worth reading. But it is precisely because Mrs. O'Connell writes it that this volume has an interest which makes it more than a mere record of Bianconi's enterprises. Mrs. O'Connell has taken such pains to be honest as to be marked off from the common throng of biographers. She loves the memory of her father, but will not say a word about him that she does not think true. She dwells reverently, but plainly, on his defects, as well as brings his merits into prominence. As this is her idea of what is right, the advantage of the biography being written by a daughter is undiminished. Ordinarily biographies written by near relatives are very painful reading, as the subject of the memoir is represented from the cradle to the grave under a glorified aspect which does away with all sense of reality. But if a daughter can be honest, she can undoubtedly say many things, give many touches, and introduce many episodes which no one out of the family circle could rival. It may, indeed, be said that unless Mrs. O'Connell had written the book, and had made it interesting by the way in which she writes, the volume ought to have been much smaller. There is not much to learn about Bianconi that is worth learning; but in Mrs. O'Connell's pages, written as they are with a sort of artless, patient, gentle honesty, there is much to read that is pleasant reading.

Charles Bianconi was born at Tregolo, near Como, in 1786, and was the son of a humble Lombard proprietor. When he was sixteen, in 1802, he was intrusted to the care of a person named Faroni, who brought him to Ireland, and he was started by his master as an itinerant vender of cheap framed prints. When released from his engagement with Faroni, he set up as a print-hawker on his own account, and, being a bright lad, was welcomed as a humble friend in the houses of some of the Irish gentry. In 1806 he set up a shop as a gilder at Carrick-on-Suir, twelve miles from Waterford, to which town he removed, and thence came to Clonmel in 1810. When peace was made in 1815, a number of horses purchased for the army were thrown on the market at very low prices, and Bianconi took advantage of the opportunity to try his first experiment in cars. He began on a very humble scale, and his main business was still that of a shop-keeper. For some time he confined his business to his own neighborhood, and although he carried some local mails, he never had capital enough to make any great advance until 1826, when an accident put him in the way of wealth. He had agreed to supply the Tories with cars at the election of 1826, but quarreled with them, and placed his cars at the disposal of the Liberals, who rewarded his service with the handsome gratuity of £1,000. His genius had now free scope. He cut his shop, married respectably, and began car-keeping on a gigantic scale. In 1830 he got a large contract from the Post Office, and in 1831 he was naturalized and became legally, what he had long been in heart, a thorough Irishman. He was the intimate friend of O'Connell, and in 1835 joined the Direction of the National Bank, which was a creation of the Liberator, as O'Connell is always called in Mrs. O'Connell's book. Honors and riches poured in on him. He was Mayor of Clonmel in two successive years. He was made a magistrate, and after some severe struggling a deputy-lieutenant. He bought land to the amount of £70,000. When his eldest daughter became an invalid he took her to Italy, was *feted* by the Pope, and had the satisfaction of being allowed to find the money for the O'Connell monument at Rome, and to control its design. When nearly eighty years of age he broke his thigh, as he would persist in riding a horse he could not manage. But his vigor was unabated, and although he sold off all his cars after his accident, he remained a very enterprising man, until at last he died in 1875, at the age of eighty-nine.

Such were the main incidents of a life which was in its way a really remarkable one. To organize a system of cars cannot be said to be a very great achievement; but it needed more than ordinary qualities, both of mind and character, that a foreigner without capital, without experience in management, without patrons, and without connections, should have arranged a service of cars or cheap coaches over several thousand miles in Ireland when Ireland was still a very poor, backward, depressed country. Mrs. O'Connell, as we have said, never tells anything but the truth about her father. She does not pretend that Bianconi was a wise or a

* *Charles Bianconi: a Biography.* 1786—1875. By his Daughter, Mrs. Morgan John O'Connell. London: Chapman & Hall. 1878.

generous or even a pleasant man. He did not trouble himself much about the matters which occupied the attention of his wife; he spoilt his son; he does not seem to have bestowed that amount of respectful consideration on Mr. Morgan John O'Connell which Mrs. O'Connell naturally thinks was her husband's due. He was unaffectedly vain, and gloried in everything which he could take as a recognition of his merits. But he had that domineering, shrewd, inquisitive, buoyant nature which fits a man to carry out a large enterprise with very humble agents. Mrs. O'Connell has done her best to give every possible information as to his cars, and how he managed them. The net result of this information is not great. But it may be said that the secret of Bianconi's success was that he could make very uncultivated Irishmen obey him implicitly; that he could get work out of every horse that had a leg to stand on, however low the price and however numerous the vices of the animal; that he looked into every detail, and was never grand, never offered the public anything better than he could afford to offer, and slowly tried experiment after experiment. The cars furnished a rude, uncomfortable mode of traveling, and the illustrations which Mrs. O'Connell has kindly given us inspire, along with admiration of the man who invented them, a feeling of satisfaction that travelers in Ireland need no longer use them. But they were a great advantage to Ireland when they were instituted. They enabled people to ride who before had no choice but to walk. They brought one Irish town into communication with another, and really served more than, to look at the prints representing them, it seems possible they should have served as the precursors of railways. Bianconi was far too enlightened a man to oppose railways in the districts traversed by his cars. He grasped the notion, which few persons in his position would have grasped, that one kind of traffic helps another, and that his cars when driven off the main roads might find plenty of occupation as feeders to the railway. Familiarly the cars were known as "Bians," and Mrs. O'Connell, having, as she tells us, consulted Mr. Anthony Trollope as to the propriety of a lady using the term, and having been assured by that excellent judge that she might use the word without any fear of derogating from the dignity of her sex, freely calls them "Bians" in her pages. They are practically things of the past now; but the daughter of Bianconi may rest assured that the Irish who can remember them cherish their memory as that of most useful and serviceable vehicles.

Bianconi was quite as Irish as any Irishman. In his relations with the humble population with which he had principally to deal he was greatly aided by the fact that he was a Catholic, and a warm and, for a busy man, a devout Catholic. He was always ready to work for and subscribe to local and general Catholic charities, and he himself felt in his early days what a Catholic had to endure in Ireland during the times of Protestant ascendency, partly in the shape of vexatious imposts, and still more in the shape of a very offensive assumption of superiority on the part of his Protestant neighbors. He had been looked down on as a small Catholic shopkeeper from the height of well-to-do Protestant tradesmen, and in no town in Ireland was the resentment against the imposts and the arrogance of ascendency more burning than in Clonmel. He became an eager politician, and devoted himself so heartily to the service of O'Connell that, although thinking Repeal a mistake, he supported the movement, and boasted that, while other admirers backed up O'Connell because he was in the right, he backed up his leader whether he was in the right or in the wrong. Besides being a Catholic and a carman, Bianconi also was in a quiet way a moneylender, and thus became familiar with his neighbors, not only through their convenience and their faith, but also through their pockets. He was, in fact, ready to do business in every possible form, and could never get the notion of business out of his head. As Mrs. O'Connell pathetically records, "The instinct of turning his money was so strong in him that he has charged me, his own daughter, his special confidante and friend, five per cent interest for money lent." Then, again, it was his way to be always doing something for somebody, especially in the way of getting people Government places and arranging their marriages, so that he came to his task gifted by nature with Irish instincts. In many ways, therefore, he was popular; he worked with the people and for them, and it was a source of honest pleasure to him that he was, as it were, giving thousands of poor people a lift every day for a moderate remuneration. In return he was well treated and well served. He could boast, to the credit of Ireland, that although his cars traveled on lonely roads by day and night, there never was an instance of any attempt being made to molest the travelers or injure the proprietor. And in every way, as time went on, he got more and more satisfied with things around him. On religious questions he retained his early fervor, and Mrs. O'Connell tells us that during the Gladstone Ministry he could not have been more triumphant if it had been Paganism that had been abolished instead of the Irish Church being disestablished. But he was only lukewarm in favor of the Land bill, and he may be said to have gradually settled down into a general state of Whig optimism. It is not unsatisfactory to Englishmen to know that this was the termination of the political career of one who was at once a foreigner and an Irishman.—*Saturday Review.*

DECLINE OF EXCELLENCE IN GERMANY.—A correspondent of *The Manufacturer's Review*, who has been traveling through Germany, describes many instances of the inferior work now produced by hand labor in that country. Whenever an artisan was called in to repair anything, the result was a mere botch; and new work was little better. Tailors and shoemakers no longer make goods that fit; furniture falls to pieces; window sashes are loose, and so on, through a long catalogue. The theory of the correspondent is that Germany's skillful workmen are attracted to other lands by higher offers of pay, while those that remain are about as much spoiled as helped by the scientific cramming and slender practical knowledge they get at the technical schools under the State system of education.

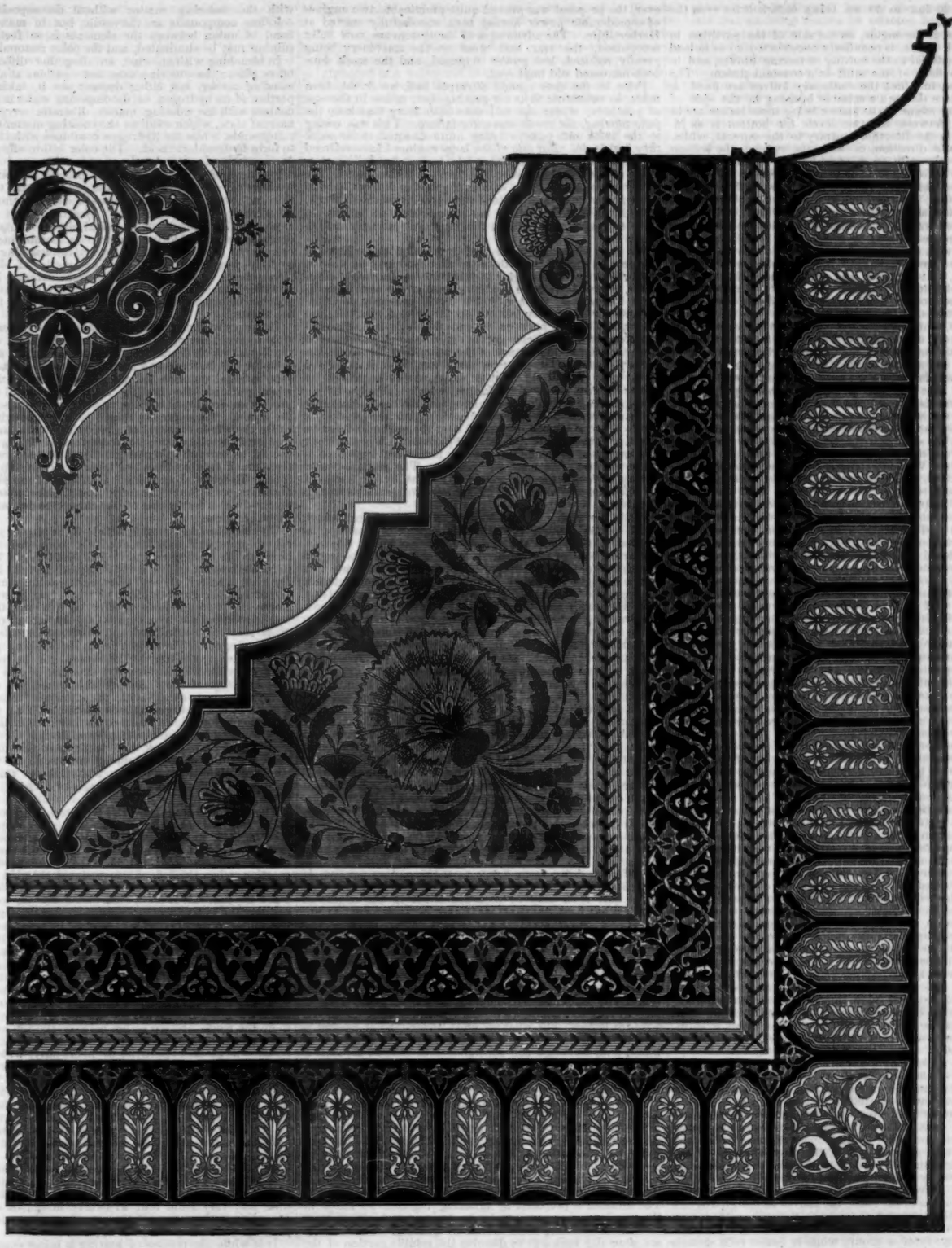
SPIDERS TRAVELING AROUND THE WORLD.—At a recent meeting of the Philadelphia Academy of Sciences, the Rev. Dr. McCook contributed an interesting essay on spiders. One species, the *Sarotes venatorius*, is distributed, with little variation in form or color, all around the world. From cabinet specimens he could trace it (going westward) from the extreme eastern limit of this continent to the extreme western coast of Africa. He has found the line of distribution to coincide with the belt of northern trade winds. He thinks the spiders migrated from point to point by throwing out fine threads and suspending themselves so as to be carried by the wind. So far as he has been able to prosecute the inquiry, there is a corresponding line of distribution for these spiders in countries swept by the southern trade winds. The theory needs further facts as to the presence or absence of these insects on islands in the ocean, before it can be fully accepted; if verified it may help to determine the open questions as to missing continents, since it cannot be supposed that the spiders could cross wide spaces of water.

M. BRONGNIART has lately had the good fortune to find a fossil spider in the tertiary marls of Aix in Provence. It is named *Attoides cressiformis*, and seems to have affinities to certain species found under stones in the present day. It is of small size, about 3·5 millimeters.

THE MOSQUE OF ST. SOPHIA.

THERE is, perhaps, no structure in Europe of greater interest to the Christian world just now than the Aya Sophia—better known as the Imperial Mosque of St. Sophia—at Constantinople. It is, so to speak, once more in sight of a Christian army, and its possible destiny, within the next few years, is matter of the profoundest importance to all who associate it with the thousand-and-one vicissitudes of the Christian churches in the East. In former days it was no difficult thing to preach a crusade for the restoration of this antique shrine to its original uses, but it has ceased, during four centuries, to be accounted among the Holy Places of Christendom. As a work of art, a type of architecture, however, it stands as, of its order, unrivaled in the East and in the West. From these points of view the edifice possesses a distinction apart from all the other historical reminiscences connected with it. We see it now, of course, as in Allove's illustrations, as it was rebuilt in the reign of Justinian, when architects wrought upon a peculiar principle—that of applying the heaviest materials in the lower part of the structure, and gradually employing lighter substances until porous stones were actually used for the vast and peculiarly expanded cupola—an example of considerable ingenuity if of somewhat eccentric theory. Signs of this are everywhere visible—ample space for light and air, tremendous strength to resist the attacks, whether of time, of war, or earthquakes. The monolithic marble columns, upholding the double ties of arches that compose the rotunda; the four Cyclopean pillars that support the dome, the immense external buttresses, and the stupendous nature of the groundwork—if so it may be termed—generally indicate a temple designed, at all events, to endure *in seculo*. And, as it is, St. Sophia at Constantinople claims precedence, in point of time, of St. Peter's at Rome, by nearly a thousand years. Not that the original Cathedral of old Constantinople, dedicated to the spirit of Divine wisdom in the reign of Constantine, fifteen hundred years, or rather more, ago, is still extant, though a part of its foundations may be, for it was twice burnt down, and even since the Justinian restoration has experienced many a disaster—notably when half of the dome fell in, crushing the holy table and tabernacle, and burying beneath its fragments the stately Eastern terrace. Once again a similar catastrophe occurred; once the high-planted cross was shaken down by a convulsion of the earth; and, from time to time, the beauty of the whole has been disfigured by discordant minarets and cupolas, added by the Turks to suit the exigencies of their own particular worship. It is a strange history which belongs to this rarest and richest of all Byzantine Greek monuments in the whole world. Twice destroyed by fire—after the exile of John Chrysostom, and during the battles of the blue and green factions—no sooner did the tumult subside than the Christian populace deplored their sacrilegious rashness; but, wrote Gibbon, they might have rejoiced in the calamity had they foreseen the glory of the new temple—whose dome no Christian may now ascend—which, at the end of forty days, was undertaken by the piety of Justinian. The ruins were cleared away, a more spacious plan was drawn, land was purchased at prices hitherto unheard of. The architect Anthemius was the designer, and his genius directed the labors of ten thousand workmen, "whose payment, in pieces of fine silver, was never delayed beyond the evening." The Emperor himself was constantly on the spot, and five years, eleven months, and ten days after the laying of the first stone the Cathedral of St. Sophia was consecrated by the Patriarch of Constantinople. As it was reared then, so, notwithstanding some disasters speedily repaired, it stands now, and neither French nor German criticism, nor, indeed, criticism of any kind, has robbed it of its reputation for uneclipsed and even incomparable splendor. No doubt the outlines, like the materials, are various—brick, granite, marble, and porphyry, white, red, green, and black, veined and starred; pillars from the Temple of the Sun at Baalbec, windows from Rome, fragments from Athens, Tyre, and Troy. Paganism was laid under a heavy tribute to assist in the rearing of this Christian fane, destined, in course of time, to become the mosque among mosques of the Mohammedan nations. Exteriorly, the complaint has been made that the eye of the spectator is disappointed by the irregular prospect of half domes and shelving roofs; the western front, or principal approach, is charged with being destitute at once of simplicity and magnificence; but, on all hands, the dome, illuminated by twenty-four windows, was long acknowledged as the first aerial cupola ever constructed. It is formed with so small a curve that the depth is equal only to a sixth of the diameter—that diameter being 115 ft.—while from the center, where the crescent has supplanted the cross, to the pavement is nearly 200 ft. Only tradition tells of the money expended, or the quantity of marble and stone, gold, silver, iron, luné, oil, barley-water, and mastic used, with precious scents, in preparing the mortar; jewels, perfumed and ornamental woods, ivory and amber that entered into the construction of this amazing pile. It was as though Justinian, in his pious pride, dreamed of emulating the splendors of Solomon. Only upon an after-thought did he abandon the idea of inlaying the floor with plates of beaten gold. In fact, there is a legend to the effect that, on the day of consecration, he ascended the pulpit, spread forth his arms, and exclaimed, "Solomon, I have surpassed thee!" In the size of the building, of course, he had, and probably in the collective wealth of its adornments; but four hundred years of Ottoman pillage have stripped the shrine of its most magnificent contents and decorations, though nothing short of absolute destruction could discrown St. Sophia from its rank among the originally Christian edifices of Eastern Europe. The general result, however, has been to introduce an assemblage of paradoxes almost grotesque in their effect—altars placed sideways; a congregation turning toward a corner; pulpits of Islam, which appear to have been thrust from their places; minarets blazing with richly-gilded crescents· the precepts of the Koran mingling with associations of the Bible, and so forth—all telling of change and conquest.

The exact breadth of the edifice—in form a Greek cross—is 243 ft.; its length 269 ft. from the sanctuary in the east to the more western doors which open into the vestibule, and thence into the narthex, or exterior portico, designed for penitents, while the nave is filled with the congregation of the faithful. There was a throne for the Emperor and a throne for the Patriarch, both of which have disappeared; but, apart from the spoliations of the Turks, the structure has suffered, considering the lapse of more than four centuries, no very serious dilapidations. Justinian, inspired by the memory of past calamities, adopted a solid resolution, which has had its lesson for ambitious builders in later days. He declared—and the historian has justified his declaration—that no wood, except for the doors, should be admitted into the new edifice; and the choice of the materials was, according to the lights of his generation, adapted to the splendor, the lightness, the weight, and the strength necessary to the respective parts. The solid piles sustaining the cupola were composed of huge blocks of freestone, hewn into squares and triangles, fortified by circles of iron, and firmly cemented by infusions of lead and quicklime. "But the weight of the cupola," as we have seen, "was diminished by the levity of its substance, which consists either of pumice, that floats in water, or of bricks—perhaps, rather, tiles of the Roman shape—from the Isle of Rhodes, five times less ponderous than the ordinary sort," but these concealed beneath the last spoils of Paganism, and by costly stones from the quarries of Asia Minor and the islands and continent of Greece, Egypt, Africa, and Gaul. The Turk, before long, was to take possession of it all. The picture of the change has been put vividly before us. Mohammed II. began by despoiling the great Byzantine Cathedral, and ended by converting it to Mohammedan uses. The dome and the altar were plundered, everything easily destructible was destroyed, and the entire structure might have become a ruin had not the Sultan himself, on the 29th of May, 1453, halted at the principal gate of St. Sophia. There he saw a trophy worthy of his triumph. He became jealous of its splendors in a moment. One of the faithful, busily engaged in breaking up a priceless mosaic, had his occupation cut short by a sweep of the scimiter; and, by Imperial command, the metropolis of the Eastern Church was forthwith transformed into a mosque; all that was rich and portable in the paraphernalia of the Christian services was removed, the crosses were thrown down, the walls, covered with images and inlay, were whitewashed, purified, and reduced to a state of simple nakedness. On the same day, or on the following Friday, the *muezzin*, or public crier, ascended the most lofty turret, and proclaimed the general invitation to prayer, in the name of God and the Prophet; and Mohammed the Second performed the Moslem rite of supplication and thanksgiving on the great altar where the Christian mysteries had so lately been celebrated before the last of the Cæsars. In this way the greatest Christian fane in the world became, as it remains, a Mohammedan shrine, and St. Sophia, "where first the faith was led in triumph home," became, as Eliot Warburton describes it, "a mosque—the most uninviting and prayerless place of worship in the world." As an architectural result of the transformation, however, after the death of the Second Mohammed the Turks, as Fergusson himself admits, abandoned their own original style of mosque-building to copy the Byzantine forms found in the city of which they had lately taken possession; and "so enamored have they become with the new form that they have never, in the capital, reverted to the usual or orthodox plan of a mosque," though in the provinces the true Saracenic style has always prevailed, with a very slight admixture of the Byzantine element. They had discovered, indeed, that the climate was not adapted for open courts, as at Cairo and Delhi, and gladly reconciled themselves, therefore, to the domes or cupolas, which confer upon Constantinople, as seen from a distance—and it is declared that the crescent on the summit of St. Sophia is visible from a hundred miles away—its most characteristic aspect. They obtained thus the shadow and shelter they wanted, but in most instances improved upon the original model. Many of the structures, indeed, erected by them in quasi-imitation of it are undeniably noble, with lofty roofs, well-calculated dimensions, built from base to dome of marble, usually white, slightly tinged with gray, with from two to six of those light, thin, lofty, arrowy, and most graceful towers to which has been given the name of minarets. But St. Sophia suffers from the hideous buttresses that have been heaped, as it were, against its external walls, piled up at different periods, without the smallest reference to symmetry. Thus the Mosque of Sultan Soliman, though far from being so historically interesting, is, in its exterior at any rate, superior to the more venerable shrine converted from a Christian to a Mohammedan use. In general aspect and form it resembles it, but is entirely unencumbered by external supports. The windows are larger and better arranged, as they may well be, considering how every point of view in the more ancient edifice has been distorted to satisfy the minute peculiarities of Mohammedan worship; the galleries have not had to undergo a violent transformation; the dome was not constructed under so many difficulties; and, above all, modern knowledge has come to the aid of artistic tradition. Should it ever happen that St. Sophia is once more required to answer its original purposes, another great transformation will necessarily take place, though not again will an Emperor, clad in a linen tunic, watch by night and day over the progress of the workmen, for the original altars—and especially that called the High, placed in a recess to the east, artificially built in the form of a demi-cylinder—the sanctuary, communicating by several doors with the sacristy, the vestry, and the baptistery; the two larger and six smaller semi-domes; the walls, the arches, and the columns; the pulpits, balustrades of the choir, and ornaments of the doors and galleries, will all have to be renovated, if not replaced. Needless to say that not one solid ounce of silver or gold has been left throughout the entire building. But its very history is a monument which survives four hundred years of conquest; and though the original structure may not remain, still there is in its traditions that which fires the Greek or modern representative of the old Byzantine artistic mind—the leveling of a mountain and the filling up of a valley for the sake of an even road; the quarries hollowed among the hills expressly to bring together the blocks, many of them requiring to be drawn by forty oxen each; the hewing down of cedars in the Lebanon forests; the tracing of labyrinthine red marble veins to be sculptured into columns and cornices; the search for the emerald-green porphyry and the white from Phrygia—all this constitutes a history of the Church prior to that of the mosque, and it is impossible not now to think of the one as it is, isolated and threatened, without reverting to the other as it was, the marvel and the glory of the Christian East.—*Building News.*



SUGGESTIONS IN DECORATIVE ART.—CEILING OF A BOUDOIR IN A VILLA IN WIESBADEN.

CEILING OF A BOUDOIR IN A VILLA IN WIESBADEN.

CENTER rosette in stucco in a warm gray color, partly gilt, with red and blue facing; surrounding ornament blue with gold and silver outlines on bluish gray ground, the border of central ornament being blue with silver dots.

Ground of ceiling buff, the flowers in the same color, but darker; escaloped border again blue with silver dots, edged with fine dark brown lines; inner stripe a dull white.

Ground of corner compartment gray, the ornament painted in various bright colors and edged with gold.

Frieze framed on both sides with stucco mouldings (see profile), the raised fillets gold, the inner sunk parts light gray with darker leaf ornament; plain borders of ornament dark gray with blue stripes, picked out with bronze lines; ground of frieze black; ornament bluish gray outlined partly in gold, partly in silver.

The ground of the hollow is black, that of the palmettes dark gray, ornament light gray outlined in gold and silver, flowers gold, the facing lines of palmette compartments are bluish gray and red, the small spandrel ornaments bronze, the ceiling cornice below the hollow light gray with gold fillets.

The walls of the room have Persian cashmere hangings with blue satin borders; the wainscot is black, picked out with bronze and gold facings.—*The Workshop.*

THE TECHNOLOGY OF THE PAPER TRADE.*

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LECTURE III.

Washing, Bleaching, Beating; Loading, Sizing, Coloring.

IN my introductory lecture I briefly adverted to the introduction of the "Hollander," or beating engine, as marking an epoch in the history of paper manufacture; we shall now have to consider at greater length the nature of this machine, and the various operations conducted in it. In our last lecture we prepared our rags, esparto, and wood by boiling for the process of pulping; this operation, or series of operations, is conducted in the washing, or breaking, and beating engines, which, together with the bleaching or poaching engine, are but modifications of the same machine. Indeed, the engines known by the three names, and used for the three purposes of washing, bleaching, and beating, are identical in principle, the details being only slightly modified. We shall, therefore, study their construction and action together.

The engine consists essentially of an oblong cistern, the ends being circular, partitioned in the center, lengthwise, so as to leave a space at each end equal to half the diameter of the vessel. In the bottom, at one side of the partition, is fixed a frame, holding a set of knives, or cutters, looking upward, and over these revolves a drum, or roll, containing another set of knives, and furnished with the means of adjustment, so that the two sets may either just touch each other or be separated by some little distance.

The engine is now almost always made of cast-iron, at least in this country, even although it should be intended for bleaching. Many of the older engines were made of wood, sometimes naked, sometimes lined with lead or copper, those intended for poaching or bleaching being generally constructed of slabs of stone, hooped with iron.

Some of the more recently constructed engines intended for washing and breaking esparto, and fibrous substances of a like nature, are of very large dimensions, and have been cast in segments and bolted together, partly for convenience in erecting them and partly on account of the expense and risk involved in casting such large hollow vessels in one piece. So long as they are strongly constructed and well put together, there can be no objection to this system. The engines I speak of measure 16 ft. by 8 ft., and 9 ft. 8 ins. deep, and are capable of taking a charge of from 8 to 10 cwts. of esparto. Engines of more moderate dimensions, such as 11 ft. by 5 ft., or 9 ft. by 5 ft., equal respectively to a charge of 4 cwts. and 2 cwts. of esparto, are cast in one piece. Whatever be the size of the engine, the depth should not be

* A recent lecture delivered before the Society of Arts, London. Lecture I., Scientific American Supplement, No. 109. Lecture II., Supplement, 110.

great, from 20 ins. to 30 ins. being sufficient for even the most capacious.

The bottom of the engine, on the side of the partition in which the roll works, is peculiarly constructed, so as to lead the fibrous material to the cutting or tearing knives, and to promote the flow of the stuff in a constant stream. The frame, or case, in which the stationary knives are fixed, is let into its place through a suitable opening in the side of the engine, the edges of the knives being some inches above its bottom. Between the two levels the bottom is an inclined plane in the direction contrary to the current, while, in the opposite direction, or with the current, the bottom rises, rather abruptly, to a considerable height above the knives, so as to form a kind of breast facing the roll. Over this breast, or "backfall," as it is called, the stuff, in process of disintegration, is carried by the knives, or fly-bars, set in the roll, which acts as a sort of lifting wheel, while along with the fixed knives it is busy tearing out the fibers. In the inclined plane referred to, a cavity is usually formed, and covered with a perforated plate; this is known by the name of the "sand trap," but it is useful in collecting all kinds of grit, nails, buttons, and similar impurities, some of which would not only impair the quality of the paper if allowed to get to the machine, but would also destroy the fly-bars, or knives, of the engine itself.

The knives, which are packed together in a frame, and let into the bottom of the engine, form what is called the bed-plate, and much of the efficiency of the engine depends upon their quality and arrangement. On looking at the construction of the machine which we have before us, it will at once be observed that the stuff in process of being pulped will not all perform its journey round in the same time, that next the partition not having much more than half the travel of that which is near the circumference of the vessel, and, as a consequence, the stuff near the center will pass more frequently between the roll and the bed-plate and get pulped more speedily. Without some special arrangement to neutralize this action, the pulp produced would necessarily be very irregular in texture. The engineman, with the aid of an oar skillfully applied, can no doubt do much to equalize the result; but no plan dependent so completely as this upon the attention and carefulness of workmen can be relied upon. Apart from any consideration of this kind, the knives are always placed obliquely, so that the action with the fly-bars will correspond to the action of scissors; besides effecting this object, however, the difficulty I have referred to is partially overcome by this arrangement, as the tendency of the rags or stuff is to go toward the forward part of the knives, and if this is next the outside of the engine it will manifestly cause a certain interchange of position to go on continually among the particles. The effect is greatly improved by "kneeing" the knives, so that each half will be oblique in opposite directions, and the forward portion of the plate in the middle of the roll. This improvement, I am told, has also been improved upon, and by increasing the number of knives at the front end of the bed-plate, and putting the "knee" only one-third from that end, better results are said to be obtained.

There is another element in this problem which must be understood before we can appreciate the nicety of the study. The roll is, as we have said, adjustable, though in most cases this is but imperfectly done; one end of the roll shaft being fixed, the raising or lowering of the other end necessarily leaves the space between the cutting edges unequal. The irregularity of action to which I have referred is thus further increased, and the tear and wear upon the various parts is, from the combination of circumstances, very irregular.

The knives themselves are variously constructed and put together, but they are generally steel-faced iron plates, packed and bolted into a suitable frame of iron incased in wood. The bed-plate must fit firmly into its seat, as the action between the roll and it, especially when tough rags are being torn up, is very severe. The extent of the cutting surface depends upon the size of the engine and the diameter of the roll; the bed-plate of an engine capable of taking a charge of 10 cwts. of esparto, which I recently examined, contained twelve knives, giving an area of forty-four inches by six. The bars which form the bed-plate of a breaking engine should be about ⅜ in. thick and laid close together, the face or edge of each being ⅛ in. thick. Beater bed-plate bars may be lighter, say 7/32 in. thick, reduced to 1/32 in. at the face, and separated from each other by plates of zinc ⅛ in. thick.

The roll to which I have already frequently referred is the complement of the bed-plate, and consists of a heavy cast-iron cylinder mounted on a strong shaft, and furnished with cutting knives or bars similar to those in the bed-plate. These bars are ground flat on the forward side, and beveled from behind, so as to form good cutting edges one-eighth of an inch thick for breakers and one-sixteenth for beaters. They are let into recesses cast in the circumference of the roll, and wedged in with slips of hard wood, the whole being further secured by iron rings let into grooves in each end of the cylinder knives and wedges. The bars are placed in groups or bunches in the rolls; the knives in the groups are about one inch apart, and the groups themselves from two and a half to four inches apart. In breaker rolls two knives usually form a group, while in beater rolls there is the usual number. The roll should fill the space between the side of the engine and the partition or midfeather as completely as possible, to prevent the lodgment of rags or imperfectly comminuted stuff which might get away when the engine was being discharged, and thereby pollute the pulp. The general character of the workmanship will determine how closely the roll can be made to work freely. The diameter of the rolls of breaking engines ranges from 33 ins. to 48 ins., and of beaters from 28 ins. to 36 ins. The speed of breaker rolls varies from 190 to 220 revolutions per minute. Beater rolls move more slowly, the number of revolutions per minute ranging from 150 to 170. The roll shaft, which must be strong, is carried on a bearing at either end; that at the further side of the engine is usually fixed, while that at the front is capable of adjustment by means of a screw and lever. I have already pointed out the unsatisfactory result of this arrangement, and there can be no doubt that the engines now being made by Bertram, Umpherston, and others, with gearing for lifting both ends of the roll equally and simultaneously, are calculated to do more uniform work and minimize the wear and tear of the knives. The proper adjustment of the roll is of the very greatest importance in the manipulation of all varieties of fiber. The roll and bed-plate should work together accurately to start with, and the slightest touch, more or less, of the adjustment screw should modify the character of the resulting pulp.

Until within the last thirty years, the driving of the roll was done by cogged wheels, and when George Bertram proposed to drive them with belts, it was averred that such a thing was absurd, and indeed impossible. In 1848, however, the proposal was proved quite practicable, two engines of considerable power having been successfully started at Herbertshire. The advantages of the system are now fully recognized, the tear and wear on the machinery being greatly reduced, less power required, and the work done both increased and improved.

Prior to the date named attempts had, no doubt, been made to substitute belts for gearing, but, unless in the case of poachers, where the roll does little more than keep the pulp moving, the result was utter failure. This was owing to the belts and pulleys being quite unequal to the work they had to do. For one of the large engines I have referred to, the driving pulley should at least be four feet in diameter, while the belt should not be less than ten inches broad. The power required to drive a breaking engine is from 10 to 25 horse-power, and for a beater from 5 to 15 is required. Such, then, is the machine which has contributed so largely to make the paper manufacture the important industry which it now is.

We may now bring forward our boiled materials, and charge the engine with them, so that they may be washed and broken in. The engine is filled up so far with clean water, which flows from a sluice placed at the end immediately behind the washer, which I will presently describe. The rags or other materials are put in behind the roll, and are rapidly drawn between it and the bed-plate; the full complement having been got in, it will soon be observed from the altered appearance of the water that the work has already begun. The question now arises, How is the dirty water to be got rid of? This is satisfactorily answered by means of what is called the washer, which is simply a lifting wheel covered with fine wire gauze, and having its discharge at the axis at the side opposite that on which the gearing is fixed. The washer is suspended over the engine and can be raised or lowered into the water at pleasure. When at work it is immersed to the depth of a few inches and kept revolving at the rate of 15 turns per minute. The impure water passing through the fine gauze is caught by the leaves of the wheel as it revolves, and discharged into a suitable trough or gutter.

While the washer is kept at work, a stream of clean water, equal to that which the wheel is capable of removing, is allowed to flow into the engine, and as the inflow is immediately in front of the washer it has the circuit of the engine to make before any portion of it can be lifted out again. It is thus brought intimately into contact with the materials passing under the roll as they are being torn and opened out. The impurities are thus effectually got at and removed. The washing is continued until the outflow is nearly as pure as the inflow, and during this time the roll should be some little distance from the plate, especially when esparto, straw, and similar materials are the subjects under treatment. When the tearing out process is carried too far during the washing, a portion of the finest of the fiber is sure to be washed away; the stuff should therefore be opened out only sufficiently to make sure of the impurities being got at, and when these are removed, and the washer lifted, the roll may be put down so as to finish the breaking or tearing, and make the "half stuff" ready for bleaching. The more thoroughly the raw material is bathed or washed, in the boiler or in vats erected for the purpose, and the soluble impurities removed, the shorter time it will have to be washed in the engine; and this is important, as there is always a certain loss of fiber in the engine washing, and the longer the process is continued the more serious the loss. So different in this respect is the practice, that washing which takes an hour at one mill is quite as well done in a quarter of an hour at another. The quantity of water used for washing varies in different mills from 1,500 to 2,500 gallons per cwt. of rags, and from 350 to 800 gallons per cwt. of esparto.

The half stuff may be bleached either in the engine in which it has been prepared, or it may be transferred to another at a lower level. This second engine is called the "poacher," the roll of which, as we have already indicated, does little more than mix the stuff and the bleach liquor. The bleaching agent, as purchased by the paper-maker, is called "bleaching powder," and occasionally, though improperly, "chloride of lime." What the precise nature of this agent is, or how to measure its value, we need not at present stay to inquire, as we shall consider these matters in a future lecture; but what we must understand at present is that the active agent in the bleaching powder is soluble in water, and, although the substance thus soluble is rather a complex chemical compound, for our present purpose we may safely take it as simply chlorine, or, at all events, as chlorine so slenderly attached to its chemical friends as to be quite easily separated and allowed to act on its own account.

The bleaching powder is generally put up in casks containing four, five, or six cwts., and the buyer generally bargains for the casks being of such a size that either one or more of them will charge one of his mixing or dissolving vessels. To be under the necessity of halving casks is neither pleasant for the workmen nor profitable for the mill-owner. The solution is prepared by agitating together so much of the powder and so much water in stone or cast-iron cisterns fitted with agitating arms driven by gearing. Three hours are generally sufficient to dissolve the soluble portion of the powder, and when that is effected, the mixture is allowed to settle for some time. The clear liquor is then siphoned off into stone or slate cisterns. A further quantity of water is run into the mixing vessel, and the lime sediment agitated with it. On again being allowed to settle, a second but weaker solution is obtained, which is run into the same cistern as the previous stronger liquor, and the result of this mixture should be about six or eight degrees Twaddell, at which strength the bleaching liquid is supplied to the poaching engines.

The exhausted lime is troublesome to get rid of, as it has no manurial value, and dare not now be put into streams. It is usually drained in ponds or tanks until sufficiently dry to be carted away to a rubbish heap or old quarry. We find an economy in using tanks for draining it, as the drainage can thus be collected and utilized: and in several instances where I have recommended this, from five to ten cwts. of bleaching powder per week have been saved in the mill. A quantity of bleaching liquor, equal to from three to six pounds of 35 per cent. bleaching powder, is required to bleach rags, while for esparto the liquor must be equivalent to from eight to ten pounds per cwt.

When the half stuff prepared in the breaking engine is run into the poacher, the water with which it is mixed is lifted out as far as possible by the washer, and the spent bleach liquor from the presses or drainers run in instead. The fresh bleaching liquor required is then measured in, and in from two to six hours the desired effect is usually produced—the pulp having become beautifully white. How this effect is brought about I must now try to explain. In the case of sulphur bleaching, the sulphurous acid combines with the coloring matter without decomposing it, and colorless compounds are the result; but in many cases the bond of union between the elements is so feeble that the sulphur may be eliminated, and the color restored.

In bleaching with chlorine, an altogether different effect takes place; the chlorine does not combine at all with the coloring matter, but either decomposes it, taking away a portion of its hydrogen, or, decomposing water in immediate contact with the coloring matter, liberates oxygen in the nascent state, which oxidizes the coloring matter to colorless compounds, while the hydrogen combines with the chlorine to form hydrochloric acid. The color is thus effectually and permanently destroyed. In many mills, and especially when dealing with esparto, the process is completed, as we have already indicated, in the poacher, and to promote this end steam is sometimes introduced, and sometimes also oil of vitriol, or sulphuric acid. Heat is almost invariably a powerful stimulant to chemical action. Sulphuric acid decomposes the chlorine compounds, combining with the calcareous base, and setting the active bleaching agent free to do its work more speedily. The practice of bleaching in stone chests is still carried on to some extent. It is usual, however, to bring up the color to a large extent in the poacher before running the stuff and liquor into the bleaching chests.

However well managed a mill may be, it is scarcely possible to avoid having a small residue of unused chlorine in the liquid which drains from the bleached stuff, and the rule is to use this in the way I have explained. That as little of this residual chlorine as possible may remain in the stuff when put into the beating engine, powerful hydraulic presses are employed to compress the stuff and squeeze out the liquid. These presses should be large enough to contain easily the whole contents of a poaching engine, and of unexceptional workmanship; the perforated lining especially should be carefully prepared and properly secured. I have seen much trouble from negligent workmanship in this respect. Recently I examined a number of samples of press drainings, and found the unexhausted chlorine to vary very much—from a few grains of bleaching powder per gallon to about an ounce.

The bleached half stuff is lifted off the tray of the press in caked lumps, and is in this condition conveyed in metallic boxes to the beating engines. The first thing to be attended to in the beating engine is the elimination of the last trace of chlorine, which if allowed to remain would injure the size or corrode the strainer plates or wire of the paper machine. There are two methods of effecting this end; the chlorine may be washed out by a copious application of pure water, or it may be neutralized and rendered harmless by some chemical agent. The objections to the washing process are that it takes up the time of the beater—for the roll must not be down while washing is going on—that it uses a considerable quantity of the finest available water, and that fiber is always washed away with the chlorine. None of these objections can be urged against the neutralizing process, but objection is sometimes taken to the presence of the chemical agents added and produced, even although they are quite inactive. I do not think there is much in this objection, as those agents that are soluble pass through the wire of the machine almost completely, while those that are insoluble are in the finest possible state of division, and pearly white.

The chemical agent most largely used is hyposulphite of soda, but hyposulphite of lime is also employed, and these agents, known by the name of "antichlore," are put into the engine in such quantity as will insure the neutralization of the whole of the chlorine. The products of the reaction, when the soda salt is used, are chloride of sodium (common salt) and sulphate of soda (Glauber's salt), and when the lime salt is used, chloride of calcium and sulphate of lime, the latter identical with the pearl hardening so well known as a loading agent. Upon the management of the beating engine the character of the paper to be produced very largely depends. What is wanted is not a mincing or grinding of the fiber, but a drawing out or separation of the fibers one from another; in fact, the name of the machine indicates pretty accurately the nature of the action required—beating. Long fine fibers can only be produced by keeping the roll slightly up off the bed-plate, and giving it time to do the work. Sharp action between the roll and the bed-plate will, no doubt, make speedy work of the fiber, but the result will be short particles of fibers only, which will not interlace to make a strong felt. Indeed, the action I refer to will reduce the long strong fiber of linen to little better than that of wood or straw. Practice and careful observation can alone make a good beater-man, and for the finer classes of paper none but careful, experienced men should be intrusted with the management of the beating engine. Sometimes the operation is conducted in two successive engines, the first being called the intermediate beater, but I have hitherto failed to see wherein the advantage of this system lies. The time usually occupied in beating esparto for printing paper is about four hours, while for rags the time may vary from four to twelve hours, or even more, according to the nature of the rags themselves, and the purposes to which they are to be applied.

It is while the process of beating is being conducted that the various loading, sizing, and coloring agents intended to be incorporated into it are added to the pulp. To these various ingredients we must now devote some attention.

The practice as to the order or rotation in which the various agents are added differs quite as much as do the methods of preparing the materials and the proportions and mixtures used. It is customary, however, to add the loading agents first, and I am clearly of opinion that it is the correct course to follow. China clay or kaolin is the loading agent most abundantly used, and while it is certainly not equal to "pearl hardening" or precipitated sulphate of lime, either in purity or brightness, it is in some respects more suitable for the purpose. It is of a more adhesive nature, and the particles, when viewed by the microscope, show a roughness of surface which no doubt enables the fiber to lay hold of and retain them better than the particles of pearl hardening, which are of smoother exterior. China clay is also specifically lighter, and consequently not so liable to settle out or go through the wire of the machine, and it has the further advantage of being cheaper than the rival agent. The great bulk of these mineral matters is added to the pulp to reduce the cost of the paper; their cheapness is consequently an important consideration.

China clay is one of the constituents of a disintegrated rock of granitic formation. The separation of the clay from the feldspar and other gritty matters is effected by a stream of water, which, depositing the impurities on its journey, carries the finest of the clay forward to settling ponds, where it subsides. The water is drained off, and in course of time the clay becomes dry enough to be packed for transportation. Good clay is soapy or unctuous to the touch,

but, unfortunately, the most accurate chemical analysis of it can tell us little as to its suitability for paper-making purposes, and the physical character of the particles of which it is composed really determines its value. A clay may be beautifully white and free from gritty matters, and yet be but ill-suited to the wants of the paper-maker. Those properties are no doubt desirable, but the clay must be of a character to be retained by the pulp on the wire of the machine, and this is precisely the characteristic upon which chemical analysis affords us no information.

Pearl hardening is simply sulphate of lime which has been prepared by precipitation. It is, accordingly, pure, and in an unconceivably fine state of division. It is beautifully white and bright, almost to glistening, and these qualities render it suitable for admixture with the finer classes of writings.

The clay, which term I shall now use in a generic sense, is prepared for admixture with the pulp in the beating engine by agitating it with water in a mixing vessel, a suitable proportion of water being about 30 gallons to the cwt. Steam is used to assist in disintegrating and diffusing it through the water. A small quantity of farina is frequently added to it in the mixing vessel, and when this swells it aids in sustaining the clayey particles in the liquid. Before being used, the clay is passed through a strainer, with the view of removing gritty and other impurities, which, if allowed to get into the paper, would detract from its purity and value. Even the finest China clay is not free from black specks and other extraneous matters, and it is well to use all the precautionary measures available to remove them as much as possible. The clay is measured into the beating engine in such proportion as has been found, by experiment, to give the desired percentage in the paper. This is done almost as soon as the half stuff has been put into the engine; it consequently gets thoroughly incorporated with the fiber before the size is introduced. The normal amount of mineral matter in paper which has not been loaded varies slightly, but may be taken at 2 per cent. When calculating what percentage of the clay used has been retained by the web, this ought not to be overlooked. Fiber in course of being made into paper will only retain a certain quantity of clay, the quantity being dependent upon the thickness of the sheet, the degree of fineness to which the fiber has been beaten, and the proportion of size used; but this does not seem to be realized sometimes, as we occasionally find makers adding clay to their pulp which can never be retained by the paper, and which is, consequently, thrown away. No doubt, since it has become customary for paper-makers to determine the ash in their papers systematically, much of the hap-hazard sort of work we have seen has given place to a more intelligent method of procedure. That so much mineral matter should have to be used by the paper-maker is much to be regretted. The introduction of some cheaper fibrous material would go far to correct the present unfortunate state of matters. And we must all wish Mr. Routledge success in his search after suitable substances.

The clay having been added to the pulp in the engine, whatever coloring matter may be required should now be introduced. It is impossible for us to go into a detailed description of the various coloring matters used at the paper-mill, but I may point out that they are divisible into two classes—those which are in solution, like the aniline colors, and those which are insoluble, or in powder, like ultramarine and venetian red. The former class dye the fiber, while the latter coat the surface only. Whatever be the nature of coloring matter, it should be added to the pulp before the size, so that it may be quite free to impregnate or coat the fiber, as the case may be. When the size has been added, the fibers are in a manner protected from the direct contact of anything that may be afterward added. Almost all fine papers, including those intended to be quite white, have a certain amount of coloring matter added to them, and it is a matter of great nicety hitting the exact shade or tone that may be required. This is especially difficult in gaslight, and, to meet the difficulty, recourse has been had to the magnesium light, which has proved of some service. I can scarcely omit referring to ultramarine, which is, perhaps, the agent most widely used by the paper-maker for giving tone as well as color to his papers. It is a somewhat complex chemical compound, occurring in an impure state in nature. Until Gmelin succeeded in producing it artificially, the mineral freed from its grosser impurities was our only source of supply. It is now produced artificially in very large quantities, but is somewhat expensive and liable to adulteration.

Besides the small quantity of farina referred to as being sometimes mixed with the clay, a much larger quantity is put into many printing and writing papers. Farina is a starch, and on being heated up with water it swells and becomes gelatinous, and when added to the pulp in this state it no doubt acts as a sort of cement, as well as helping to fill up the interstices among the fibers. Undissolved starch is also sometimes put into the engine, in the belief that, as the wet paper passes over the drying cylinders of the machine, it is heated sufficiently to cause the starch to swell, and thus help to improve the texture of the web, making it closer and smoother. I very much doubt that this effect really does take place. That starch so added does exercise a sizing effect upon paper not otherwise sized we have ample evidence, and this would lead one to infer that the heat had actually produced the effect which we have questioned; at no stage of its journey, however, does the paper attain the temperature which is regarded as requisite to swell starch.

The engine is now ready to receive its complement of size. Writings that are intended to be tub or surface-sized are not usually sized in the engine, but all other writing and printing papers are. The size used in the engine is essentially a resinate of alumina, although doubts have been expressed as to the resin and alumina really being chemically companionized; indeed, some authorities assert that the two agents are but mechanically united. Though this is a point of some interest to the chemist, it does not very much concern the practical paper-maker. The sizing compound, whatever be its precise nature, is produced by adding a solution of alum or sulphate of alumina to a solution of resinate of soda. The reaction between the substances is simple—the sulphuric acid of the alum combines with the soda of the resin compound, producing sulphate of soda, while the alumina and resin are precipitated together. The reaction I have described takes place in practice in the engine. The resinate of soda or resin soap is added first, and thoroughly incorporated with the pulp, the alum solution being added just before the beating is completed.

We are now in a position to consider what the effect of leaving free acid and chlorine in the half stuff would be when the resinate of soda is introduced. The chlorine would at once seize the soda and liberate the resin quite uncombined. In the free state resin is not a friend of the paper-maker, and there can be no doubt that when liberated in the way indicated it is calculated to impair the character of the paper produced to a serious extent. Only the other day, a writer in a German journal pointed out that free resin is as good a sizing agent as resin alumina, if only it be precipitated in a milky condition. How the paper-maker is to insure this result the writer does not point out, and I am unfortunately unable to throw any light on the subject.

Acid pulp that is not sized in the engine must, of course, cut up the strainer plates and wire of the machine, and I have observed that the bars both of the roll and bed-plate of the engine are seriously affected from the same cause, as well as from the use of too much alum or acid sulphate of alumina. This is especially noticeable when the bed-plate bars are separated from each other by layers of zinc, and is, no doubt, attributable to galvanic action. As a rule the loading or coloring matters have no neutralizing effect. Washing the bleached half stuff, or alternatively neutralization of the free acid by means of some chemical agent, must, therefore, be regarded as important if not essential.

With the nature and valuation of the various chemicals involved in the sizing process I shall deal in the fifth lecture; meantime we must inquire into the preparation of the resin soda compound. Surprise has sometimes been expressed that caustic soda has not been found the best agent with which to treat the resin in the preparation of resin soap or resinate of soda. The explanation seems to be that the action of caustic soda is too violent, the soap produced being essentially different in its nature from that produced by the milder carbonated alkali, and not so readily decomposed by the alumina compound. Crystal soda is no doubt the purest agent that can be used for the preparation of size, but good soda ash is quite suitable and cheaper. Every maker has his own formula for the making of resin soap. The vessel in which the substance is to be prepared should be metal, preferably heated by means of a steam jacket, although in most cases the steam is introduced into the mixture itself. The ash or crystal soda should be dissolved in as small a proportion of water as convenient, and, when boiling, the powdered resin will be gradually added until the requisite quantity has been got in. The whole will then be frequently stirred, and maintained at the boiling-point until the resin is completely in union with the soda. The proportion used may be about two of resin to one of soda crystals, and four to one of good ash. The time occupied may vary from one hour to six hours. What has to be aimed at is the complete absorption of the resin by the soda, so that none of the former will be left free in the soap. Excess of soda will do no harm, while excess of resin will show itself in the form of specks on the paper. It is consequently safe to err on the side of an excess of soda rather than risk having any free resin in the soap. To test whether the soap has been properly prepared, a sample may be drawn and dropped into a basin of cold water, when it should dissolve readily and completely on being agitated, and if this is done by the hand, the presence of free resin, if any, will be shown by the adhesion of the particles to the hair on the back of the hand. If on applying this test some of the resin be found to be uncombined, and further boiling fails to rectify this, more soda must be added. The resin soap is measured into the engine through a wire cloth strainer in the proportion which is found suitable for the class of paper being manufactured. Experience coupled with a knowledge of the precise nature of the materials used and the reactions which result from their application can alone determine the quantity which it is requisite or desirable to use.

The fibers in the engine having been beaten out to the required fineness, and the requisite loading, coloring, and sizing agents added, the contents of the engine are discharged into the stuff chests or vats in the machine house, where we must, for the present, leave the pulp.

Before concluding this lecture, however, I must not omit referring to the important subject of mixing or blending. Many of our vegetable and woody fibers are ill suited of themselves to make strong papers. Esparto, straw, and wood fibers are frequently mixed in various proportions with longer and stronger fibers—from 5 to 15 per cent. of linen or hemp, for example. In the production of fine writing papers the mixing of linen and cotton is also largely practiced; and indeed there is no end to the variety of mixtures used for the production of the various classes of paper.

I must also make brief reference to the fact that, besides the beating engine I have described, several other machines for the same purpose have been devised. Perhaps the most worthy of notice is the disk engine, which is, we believe, doing fairly good work in several mills in this country, and more largely in America. There are various forms of this machine, but the essential features of them all are that the work of pulping is accomplished by moving disks, rotating rapidly in close proximity to stationary ones, both being grooved, or supplied with knifes or cutting edges, and that the stuff is fed in and discharged in a constant stream. We have not had the opportunity of examining these machines, and cannot, therefore, speak confidently as to their capabilities, but those who have them at work speak favorably of them.

SOAP AND SOAP PLANTS.

A PECULIARITY of soap made from cocoanut oil is that it dissolves in salt water. Ordinary soap is insoluble in salt water, and advantage is taken of this fact in its manufacture. When a solution of soda is boiled with ordinary fats the stearate of soda remains with the glycerine, suspended in the water of the solution; but if a solution of salt be added, the soap separates and floats on the surface, whence it can be easily removed. As soap is also insoluble in strong alkaline solutions, the same result is sometimes attained by boiling down the soap to a certain consistency, when it separates from the excess of alkali. Soaps made from cocoanut oil are treated in this way.

All soaps retain more or less water on solidifying; the least proportion being about thirty per cent. of their weight, while the highest is about seventy-five per cent. Cocoanut oil soap is remarkable for the large amount of water it can hold. The great part of the water, but not the whole, can be removed by drying. The venders of soap prefer, of course, to prevent this loss of water, and therefore store the article in a damp cellar or the moistest locality accessible. The figures above give the percentage of water in freshly-made soaps, the highest referring to those made with cocoanut oil; but it is stated on good authority that soaps have been known to be sold which contained from 83 to 154 per cent. of water. The popular preference for mottled soaps is based upon the idea that they hold less water than other kinds. The mottling is caused by a compound of the fatty acid with oxide of iron, which arranges itself in veins through the mass. If the soap contain too much water, this iron compound is likely to settle to the bottom during the process of solidification, leaving the product clear. It is said that mottling cannot be effected honestly when much more than thirty per cent. of water is present; but, by a trick of the trade, an imitation is produced with more watery soaps by stirring into them when partially solidified some sulphate of iron and a little lye containing sulphide of sodium, the chemical reaction which ensues producing the dark sulphide of iron in the pasty mass.

The making of toilet soaps is a mechanical rather than a chemical process, the usual method being to remelt and clarify a good white soap, and to add various perfumes and colors to it before it is solidified again. Many of the cheaper kinds differ little from common bar soap except in the scent, which in some cases hardly disguises the original odor. The colors employed are usually vermilion, ultramarine, ochre, and other harmless substances, and the perfumes are essential oils, like those of cinnamon, lavender, rose, etc.

Soap is readily soluble in alcohol, and this fact is utilized in the making of liquid soaps and of transparent soap. To prepare the latter, white soap is dissolved in alcohol, the impurities are allowed to settle, and the clear solution is drawn off and solidified.

Soap is used to a considerable extent in medicine, both externally and internally. It has laxative and antacid properties, and is on that account used as an ingredient in pills, as also to prevent them from becoming hard and insoluble. As an external application it enters into the composition of many liniments, plasters, and cerates. A strong solution of white soap is a useful antidote in cases of poisoning with the mineral acids, if alkalies are not at hand.

Calcium or lime soap is employed in the manufacture of stearine; zinc soap is used as a pigment, and, like lead soap, in medicinal plasters; copper soap is used in preparing water colors; gold soap, in gilding porcelain; and silver soap, in giving a dark color to the hair. Aluminium soap is used in certain waterproofing processes. The fabrics are dipped into a solution of acetate of aluminium, and then into soap-suds, aluminium soap being formed by the double decomposition. Other metallic soaps have various technical applications, but our limits forbid us to dwell on the subject longer.

A large number of vegetables contain a principle called *saponine*, which has a remarkable resemblance in its action to soap, and hence they are used in various parts of the world as a substitute for that article. The *Sapinda saponaria*, a tree growing in the West Indies, bears a fruit (sometimes called the soap-berry) the pulp of which is used for washing purposes. It is said that its detergent power is equal to that of sixty times the weight of soap. Other plants of the same genus have similar properties. There is also the genus *Saponaria*, commonly known as soap-wort, both the roots and the leaves of which contain saponine. Some species of the genus *Gypsophila* are likewise rich in this principle. The Egyptian soap-root (*G. struthium*) and the Spanish soap-root (*G. Hispanica*), known in Spain by the name of *jabonera*, have been employed for washing from time immemorial. They are exported to some extent, being used for cleansing silk and other fabrics which will not bear the application of soap. In Chili and Peru the bark of the *Quillaja saponaria* is in common use as a substitute for soap, and forms an important article of commerce in those countries. A species of vine (*Vitis saponaria*) growing in some of the tropical South Sea Islands is another plant of this class. The stem, cut in pieces and softened by cooking on hot stones, produces in water a thick soapy lather. The berries of the *Solanum saponaceum* are utilized for a similar purpose; and this by no means exhausts the list of vegetable soaps.—*Boston Jour. Chemistry.*

NATURAL AMBER.

By M. REBOUX.

ALTHOUGH a little amber has been found everywhere, there are known hitherto only two principal centers of its production—Sicily, which was the source whence the ancients derived this precious material, and the shores of the Baltic, which at present supplies the entire world.

In the eocene epoch, the site of the Baltic was occupied by an immense forest, which comprehended almost the whole of the northern continent. On dredging at the depth of two meters below the bottom of the sea, there have been found thirty-two species of coniferous trees, one poplar, one alder, two willows, a chestnut, and some junipers. From the coniferous trees flowed a resin, which, after having undergone a transformation in the earth, has become amber, the largest portion of which has been derived from the *Pinus succinus*. More than twelve hundred species of objects, animals, vegetables, and minerals, have been found embedded in lumps of amber.

It is generally procured by mining or dredging up from the bottom of the sea. Formerly, it was found upon the strand after storms. In Prussia it is a right of the Crown, and no one may mine for it on his own property without paying a tax to the Government, which brings in about £24,000. The total yield in 1874 was about 350,000 lbs.

Natural amber may be distinguished from factitious amber, and from other substances which have a physical analogy with it, by the following character:

Copal is yellow, darker or lighter, but always self-colored; on its surface are generally some yellow points, like crystals of sulphur. Amber, on the other hand, is always of a different shade at one end of the lump from the other.

If a specimen is rubbed upon the palm of the hand, near the little finger, for some seconds, and a strong, aromatic odor is given off, it is amber; copal and factitious amber are inodorous.

After long exposure to the air, amber sometimes loses its essential oil and its characteristic appearance; but if copal be scraped with the edge of a sharp knife, a fine dust is disengaged, which *rises* in the air; if amber is similarly treated, the scrapings *fall*.

If amber is covered with the tallow of a candle, and moved about over the flame, it may be bent. The side upon which it is desired to bend it should be heated the more strongly, and if it is then strongly pressed upon both ends it bends accordingly. Factitious amber and copal cannot be bent.

Native amber is always harder than artificial amber and copal. Upon pressing a corner of the sample with the edge of the teeth, if it is copal or factitious amber it crushes like dried bread; genuine amber resists, and is crushed only with difficulty.

Amber resists scratching with the nail, which penetrates copal or factitious amber.

Amber may be cut, rasped, sawn, or polished, but can never be cemented or soldered, like the other substances mentioned above.

In making varnish, copal is melted in a copper pan, over a bright fire, at a temperature slightly elevated. At 212° the

water contained in the resin forms a considerable vapor; when melted, copal preserves its yellow color.

Amber does not melt below the temperature of 752° Fahr.; it blackens, and gives off a manifest odor of sulphureted hydrogen. If 33 per cent. of linseed oil be added, it melts at 310° Fahr.

The specific gravity of amber is from 1·09 to 1·11; that of opal is 1·04, and that of factitious amber 1·05, but slightly variable.

Genuine amber yields, on distillation, needles of succinic acid; the copals yield nothing similar.

If used in making cigar-holders, factitious amber melts as soon as the fire of the cigar reaches it; copal does not melt, but splits into fragments. Genuine amber resists the heat.

According to Schrötter, yellow amber consists of—

Carbon	78·82
Hydrogen	10·28
Oxygen	10·90
	99·95

—Annales de Chimie et de Physique.

ON A NEW THICKENER.

By M. G. VAUCHER.

M. ALFRED TISSOT, of Asnières, near Paris, has recently obtained a new product for thickening colors, which he calls ly-cho, and which ranks among the artificial gums.

Ly-cho has a considerable analogy with the gums properly so called, and approximates especially to tragacanth, most of the characters of which it possesses. It is met with as a white powder, slightly yellowish, resembling dextrine, and having a strong odor, resembling that of tea.

After having been well worked up with cold water, and left to itself for about twenty-four hours, it yields a thick, neutral solution, without much cohesion, and colorless, like that of tragacanth.

This solution, which may be easily let down with water, is coagulated by the per-salts of iron, the sub-nitrate and sub-acetates of lead, and the nitrate of mercury. It also gives a precipitate with alcohol.

If heated with eight times its weight of nitric acid at specific gravity 1·36, ly-cho yields mucic and oxalic acids. If treated with muriatic acid containing 2 per cent. of real dry acid (about 2° Twaddell), it yields glucose. If heated to 230° Fahr., it loses 20 per cent. of water. If calcined strongly, it leaves about 14 per cent. of ashes. If merely carbonized and treated with water, traces of chlorine are found, as also a notable quantity of sulphuric acid and of soda.

On examination with the microscope, no organic structure is apparent.

In contact with tincture of iodine a reddish color is observed, analogous to that produced by the same reagent in the extract of malt.

2¾ ozs. ly-cho yield 35 fluid ozs. of mucilage (1¾ pint), equal to that produced by the same weight of gum tragacanth; but as ly-cho is offered at 4½ francs, while the tragacanth, taken for comparison, costs 6 francs, 1¾ pint of ly-cho gum water will cost only ¾ of the price of the same quantity and strength of gum tragacanth water. Besides, tragacanth requires to be boiled, while ly-cho does not.

It will, therefore, be advantageous to use this new thickening in printing, *e.g.*, with the aniline colors; the luster of the most delicate shades is not impaired, and the yield in heavy shades is good.

Aniline violet, however, cannot be thickened with mucilage of ly-cho.

My experiments in thickening mordants with the new gum have been for the most part successful.

I have, for instance, printed red liquor thickened comparatively with

Gum tragacanth,
Gum ly-cho,
Gum senegal.

After dyeing an artificial alizarine, I found that the shades obtained by the use of ly-cho were as full and as bright as those produced with gum tragacanth.

Black, purple, and rose mordants thickened with the new gum gave very satisfactory results.

For preparing steam blues, steam and Havraneck greens, the gum ly-cho does good service, and in certain cases may be substituted for gums senegal and tragacanth and for white starch, which are in use at present. By adding it in a direct manner to the colors, the heaviest shades may be easily produced.

Thus, for thickening a steam blue taken at random, I used, to thicken 43¾ pints of color (tin pulp, yellow and red prussiate, tartaric acid, and sal ammoniac), 19¾ lbs. gum senegal, while 2 lbs. 12¾ ozs. of ly-cho thickened the same quantity of the same color equally well.

In printing fast indigo blues the new gum will be found useful, and I have found that it admits of successful applications when mixed with other thickeners, whether animal or vegetable.

If this thickener, when produced on a large scale, gives the same results as those just mentioned, I am persuaded that it will render important services to colorists.—*Teinturier Pratique.*

BLUE BLACK ON GARMENTS WITH COTTON WARPS. (ABOUT 22 LBS.)

WHEN the garments have been cleansed, boil for about half an hour with 14 ozs. solid extract of logwood. Take out and add to the kettle 3 lbs. 4 ozs. of a mixture of equal parts copperas and blue-stone, and 1¼ oz. of turmeric. Enter afresh, boil for an hour, lift, air for two hours, and rinse.

The wool or silk being thus dyed black, the cotton is treated in the following manner:

A cold solution is made up of 17 ozs. extract of logwood and 2¾ ozs. extract of fustic. Enter the garments and steep overnight, keeping them completely under the surface. The next morning lift and enter in another beck of cold water, containing the solution of 17 ozs. of the mixture of copperas and blue-stone; turn well, keep the goods well spread out, and after a quarter of an hour lift and rinse.

At the same time, add to the extract beck 3½ ozs. crystals of soda, stir up, and enter the goods, keeping them well spread out. Let them remain an hour, lift, and add to the beck 2 lbs. 8 ozs. copperas. The goods, after being well rinsed, are re-entered, steeped for half an hour, lifted and washed.

The same process gives a raven black if the quantity of turmeric is doubled and that of fustic tripled. Or the following process may be used:

Mordant for an hour in a beck of

Copperas	6 lbs. 9 ozs.
Blue-stone	2 lbs. 3 ozs.
Argol	7 ozs.

Wash and rinse. Make up the dye-beck with

Logwood	4 lbs. 6 ozs.
Turmeric	4¼ ozs.

Enter, raise to a boil for an hour. The dyeing of the wool or silk is thus completed.

The cotton, which appears of a light gray, is dyed in a beck of cold water with

Logwood	4 lbs. 6 ozs.
Fustic	1 lb. 1⅓ oz.

in which the garments, well spread out, are let steep overnight, lifted the next morning, and plunged into a fresh beck of cold water, in which have been dissolved—

Bichromate of potash	3⅓ ozs.
Blue-stone	7 ozs.

Stir up well, and, after steeping for a quarter of an hour, lift and rinse.

To the first logwood beck add 20¾ ozs. soda crystals, and enter the goods, well spread out; lift after a quarter of an hour, add 3¼ lbs. copperas, stir, re-enter, and let steep for half an hour. Lift and rinse finally.

If it is desired to obtain a blue black of this second process, the turmeric in the first color beck is omitted, and only half the quantity of fustic is employed.—*Moniteur de la Teinture.*

LOUPES.

THIS article of trade is much sought after in the mountains separating the Caspian provinces from Irak, or Persia proper. As is well known, *loupe* is the French term for the great burrs, wens, or excrescences on trees, from which the handsome veneers are cut, for inlaying fancy furniture. Walnut, maple, wainscot oak, and other cabinet woods yield these finely marked curled excrescences. It is only produced in the highlands, where it may be purchased at a very low rate; but, owing to the labor attending its transport in a country destitute of means of communication, it costs too much for speculative purposes to bring it down to the ports of shipment. Some good specimens of this valuable excrescence were, notwithstanding, brought down last season. The best marked samples of this wood are sent to England *via* Tiflis, while the ordinary qualities suit best the French market. Some loupes are to be found weighing upward of a ton, but, owing to the want of means of transport, they have to be reduced in size. It would repay curiosity to witness the process by which these hard blocks of timber are cut up into sheets almost as thin as writing paper, for veneering purposes. The loupe is introduced into a large receptacle, and steamed for several days consecutively, until from the adamantine hardness it naturally possesses it assumes the consistency of cheese. It is then placed under a machine, which, with a large blade, slices it off into sheets, which harden by exposure and are sold in the market according to size and beauty of design; some loupes, in Paris, have fetched as much as £800 sterling.—*Br. Consul Churchill's Report.*

COIR, OR COCOA-NUT FIBER, AS A PAPER MATERIAL.

EXPERIMENTS have been made in France which go far to prove that coir, or cocoa-nut fiber, is well qualified to take rank among the paper-making materials known to commerce. Hitherto it has been used exclusively for the manufacture of cocoa-nut matting, the refuse being burnt. At the experimental trials referred to, which were conducted by the publishers of the *Journal des Fabricants de Papier*, eight hundred-weight of fiber was converted into paper, and although the latter was not made on the machine, but in vats, the experimentalists do not hesitate to assert that the fiber may be employed for all kinds of white paper for which esparto is used; they even believe that a better paper may be produced from coir than from esparto. Further trials on a larger scale are projected.

GLYCERINE IN THE FIXATION OF INDIGO.

By M. PRUDHOMME.

BEFORE entering upon the question which forms the subject of this notice, I will briefly refer to the labors of my predecessors.

I will mention, in order of time, the steam indigo blue with cyanide of potassium, of E. Schlumberger and A. Scheurer's applications of the hydrosulphite blue of Schützenberger and Lalande. Then come two papers more closely connected with my work, the germs of which they contain. That of M. Jeanmaire treats of a fast alkaline blue with tartrate of iron. The author, it must be especially noticed, points out the advantageous influence of glycerine upon the fixation of fast blues. The more recent process of Zürcher is a new method for the production of an indigo steam blue, which, though it has not been adopted in practice, is nevertheless interesting.

By printing a color of indigo, oxide of tin, as a paste, or an alkaline bicarbonate, he succeeds in reducing the indigo upon the fiber. The results obtained were good only with swatches steamed on the small scale, *i. e.*, in a strong current of very moist steam, constantly renewed.

M. Jeanmaire, who was commissioned to report upon this process, confirms the conclusions of Zürcher, and shows that the alkaline carbonates may be used in place of the bicarbonates. He made also certain reservations as to the causes which might promote or hinder the reaction during steaming.

If we seek to reduce indigo suspended in water by means of alkaline carbonates and oxide of tin in the state of paste, the reaction is imperfect, even on prolonged boiling.

If instead of water we use glycerine, we obtain, after boiling for a few minutes, a solution of yellow indigo, perfectly reduced.

The reaction begins even in the cold, for the liquid takes a more and more greenish tint, but it is not complete and distinctly shown by the yellow color, characteristic of the solution of dissolved indigo, until it has been raised to about 230° Fahr.

If we, then, printa color composed thus—

Ground indigo	1¼ oz.
Oxide of tin	5¼ ozs.

adding cold 17½ fluid ozs. of solution of gum and glycerine, and 10¼ ozs. of soda crystals, it behaves like the corresponding color of M. Zürcher, where water is used instead of glycerine; that is to say, it only gives good results when steamed upon a small scale.

Upon tissues prepared with fatty acid the color is more beautiful and solid.

This blue, however, like all indigo blues, even when already fixed on the tissues, is impoverished and turned gray on steaming.

The temperature of 230° Fahr., of which I spoke above, led me to think that as my glycerine color did not yield better results on steaming, the conditions of temperature or of pressure were at fault.

I therefore performed some experiments which did not confirm this supposition, but which led me to a singular result.

The unreduced color mentioned above was printed.

1. A swatch was put into boiling water without the appearance of any trace of reduction, however the contact was prolonged.

2. The boiling point of the water was raised to 239°–248° Fahr. by the addition of nitrate of soda (a salt without reductive action), but the result was no better. It was the same with oil heated to 248° Fahr.

3. On substituting glycerine for the water, heated to a boil, the color was reduced upon the fiber, turned yellow, and then became reoxidized on exposure to the air.

Returning, therefore, to the idea that glycerine possesses especial reducing properties, I began a series of experiments, which, to exclude all error, were made with pure glycerine at 28° B., and which contained neither lime, sugar, glucose, nor dextrine. Its boiling point was about 284° Fahr. I found that glycerine alone, heated along with caustic soda, reduces indigo. Glycerine and oxide of tin lead to the same result, or rather to the precipitate of white indigo.

If oxide of tin, in the form of a paste, was thrown into the glycerine I used when at a boil, there was a tumultuous reaction, probably due to the expansion of steam, and indigo was instantly reduced. With common commercial white glycerine at 22° B., it is needful to boil it for some time.

The brown commercial glycerine at 32° B. need not be mentioned, being strongly charged with lime. The action of caustic soda upon glycerine at elevated temperatures consists in the production of acetate and formiate of soda, with the escape of hydrogen.

Glycerine has the power of augmenting the reductive action of other bodies. Zinc powder and glucose, along with an alkaline carbonate, reduce indigo more rapidly and profoundly in presence of glycerine than water.

To sum up, therefore, we have in hand two new reducers of indigo, and, however imperfect its condition, a new method of fixing one of the most ancient coloring matters known, in addition to the procedures of fast blues, steam blues, and China blues. Indeed, it may be said to include the other three. As the coloring is printed or unreduced, it is a China blue; as it contains a part of the reducing agents, it is a fast blue; as the reaction takes place at high temperatures, it is a steam blue.

In the course of these researches I have often used as a thickener gum senegal, dissolved in glycerine (2 lbs. 3 ozs. gum in 35 fluid ozs. of white glycerine). A color made up with this thickener, after the analogy of those mentioned above, keeps indefinitely. The same color, thickened with gum water, coagulates the next day. Starch paste with glycerine has the same advantage as compared with ordinary starch paste. Albumen dissolves in glycerine at 158° F. without coagulating. Gum-water, mixed with a little albumen water, has the same properties as compared with gum water alone.—*Soc. Indust. de Mulhouse.*

ON ELECTRICITY IN DYEING.

By M. L'ABBE VASSART.

IN dyeworks, the electric light is likely to render particular services as a light enabling the dyer by night, or in cloudy weather, to continue work which requires an exact appreciation of shades.

In the first attempts made at Roubaix, in the dyeworks of MM. Motte and Meillassoux, the same gradations of color and varieties of tone were recognized as in the daylight. All the dyers present agreed that matching off shades was perfectly practicable. A machine was fitted up at the works of Hannart Brothers, at Wasquehal, and has been in use every evening during the last winter.

It has been found practicable to dye by the electric light, greens, blues, and pearl grays, the quantity of the latter shade turned out having greatly increased since the introduction of the Gramme machine.

Another 100-burner Gramme machine has been fitted up at M. Gaydet's, at Roubaix, and has been in use most of the winter. It has been found that the electric light enables them to dye all shades to pattern except grays obtained by different methods, that is, when the red, the blue, and the yellow serving to produce them are not of the same nature.

But the electro-dynamic machine, so particularly advantageous in dyeing as a substitute for daylight, may also be capable of other applications in this branch of industry.

If we seek to explain the phenomena which occur in the bleaching of vegetable fibers, we cannot fail to perceive that at the foundation of all these procedures, however different in appearance, such as exposure on grass, bleaching with chlorine, with the hypochlorites, the manganates and permanganates, bichrome, and sulphuric acid, etc., there is one action in common, that of ozone.

Further, a great number of the artificial coloring matters are obtained by the oxidation of aniline, or its derivatives, by means of bichrome, chlorate of potash, arsenic acid, etc., and aniline black has been already produced directly by passing an electric current through the solution of a salt of aniline.

As the dynamo-electric machines have become economical sources of electricity, could they not produce ozone, or active oxygen, under conditions available in the arts?

Would it not be possible to regulate its action for bleaching fibers, and to take advantage of its remarkable properties in the preparation of some of these colors?—*Soc. Industr. du Nord de la France.*

MR. A. R. WALLACE reckons the entire number of species of humming-birds at four hundred, with distinct colors, form, structure and habits. He thinks the family is one of high antiquity among birds, and that its members are practically unmolested by rapacious animals. Their activity renders them difficult prey, and a humming-bird is hardly large enough to be an appetizing morsel. Mr. Wallace mentions their combats as evidence of the surplus vital energy of these smallest and most active of all birds.

APPEARANCES *versus* REALITIES.

PHOTOGRAPHY is always held up as a model of truthfulness, and, in a restricted sense, justly so; but it is only in a restricted degree that I can indorse this character, granting even the use of non-distorting lenses and properly adjusted and managed cameras; and it is this very character of truthfulness that makes photographic deception, whether intentional or not, to be so full and complete. Thus, Mr. Breese's moonlight effects were so wonderfully contrived as to deceive not only the general public, as they did so utterly, but photographic experts also. The pictures appeared to be taken by the light of the moon, but were not so taken.

How often, again, do we hear complaints, and see examples giving just grounds for them, of perspective so exaggerated as to give misleading representations of the proper sizes of objects; while, at the same time, the pictures are quite correct, their fault being an injudicious selection of standpoint and the introduction of objects lying too close to the spectator! That they are correct is easily proved by placing a sheet of transparent glass between one's self and the view, and, keeping the head stationary, marking out leading points and lines of various objects seen beyond; they would coincide to a hair's breadth with the same picture taken in a photographic camera from the same spot. The picture may be made in this manner the exact size of the photographic one by moving the glass to and fro till it is in such a place that any given object drawn upon it so that the drawing covers the object looks as large as it does in the photograph; the rest will then all follow.

This drawing of a picture upon a sheet of glass is the theory upon which the system of perspective, mathematically and exactly treated, is built. Any object of known dimensions, and at a known distance from the glass, can be depicted by the aid of the rules of perspective so as to coincide exactly with the photographic representation; and the different distances of the theoretical plate of glass—"the picture plane"—may be considered as analogous to the various foci of lenses that can be used to photograph with. Hence, it follows that, mathematically and truly, a comparatively short focus lens depicting a very wide angle of view shows us exactly what we do see. Yet we are not aware of it; our senses are deceived by the relative magnitude of objects, and our brain refuses to accept the image presented to it, because it has brought for its mental digestion such an association of ideas as it is not accustomed to.

The same thing exists in everyday life in a remarkable manner. No sooner is an object brought before us for a rigid scrutiny, which ordinarily we see only in a slight and temporary manner, than we perceive such a variety of peculiarities that we never dreamed of before; and if the object be brought before us, not only for close scrutiny, but in an unusual position or in an uncommon conjunction of circumstances, then many of its attributes before unknown are instantly perceived. Take the most usual instance—a face to be photographed. Few faces in existence are quite symmetrical; but, except in gross instances, neither to their owners or their owners' friends is the fact perceptible; and, when the picture comes home, how frequently is an outcry raised against it on account of that "nose so crooked and those eyes so odd," often taken back at once to the photographer with the complaint repeated to him, and at other times compared with the original, and want of symmetry actually existing for the first time perceived!

Another example I present to my readers:—

8 8 8 8 8 8 8
8 8 8 8 8 8 8

Here are a row of letter S's and of figure eights, taken at random. At a casual inspection the reader might say the letters were symmetrically made—that is, the top and bottom lobes of the figures and letters the same size—though upon a close inspection he would either say that it was doubtful whether any difference existed or he would notice the true relation that exists, the top lobe being the smaller. Let him, however, turn this page upside down, and the most cursory glance possible will show him their shapes, and the dissimilarity between the upper and lower halves will strike him with astonishment if he have never tried the experiment before.

Thus, also, with regard to natural objects and their appearances. Everything depends upon their being viewed from an ordinary standpoint. If any position at all unusual be chosen for viewing them from, their appearance undergoes a change from what the mind is accustomed to, and if so depicted an effect of untruth would be presented. Figures are introduced into pictures to give effect—often with ludicrous unreality as to the true size relative to objects about them; and so when they are printed in photographs from a separate negative due regard should be had to appearances as opposed to realities. Thus, if it be desired to place a group of figures at a distance (say) of a hundred yards from the spectator, they would be printed in of appreciable size as to the mind their appearance would require to be done. To test the effect, however, let an observer ascend a high steeple of a church—as high as the distance I have just named. The people below him present such a pygmy aspect that if he were to depict them he would place tiny dots in place of the comparatively large figures in the group I instanced—a difference far greater than would be warranted by the effect of looking at the figures endways, so much do unwonted conditions react upon the judgment.

I may conclude my notes by a further reference to the object that suggested them—the moon. The secret of the moonlight effects of Mr. Breese, in one respect, was found out, and numbers of pictures were produced in imitation—a very conspicuous white moon being frequently added, suggestive of a wafer having been stuck on to the negative—and much sarcastic criticism was spent upon them. The question arose, How large was the moon to be to have a natural effect? To answer this exactly is no easy task. Every one is familiar with the harvest moon, looming large above the horizon—as large, apparently, as two or three ordinary moons rolled into one. I have no doubt that I shall surprise many of my readers when I tell them that this large size of the moon is a purely *mental* effect caused by the real image on the retina being brought close to objects of familiar and known dimensions, *e. g.*, trees, houses, etc. Really the harvest moon occupies the same area of space upon the retina as it does when high up in the heavens. Any doubt on the matter will be at once set at rest by viewing the harvest moon, telescope fashion, through a piece of paper rolled up and held in the hand. At once it appears diminished in size, while when high up in the heavens no diminution in apparent size would be seen through the rolled-up paper.

Still I have not answered the question, and I do not intend to give an entirely definite answer; but, instead, will supply a final means of comparison. Naturally the moon should be represented as large as it appears to be, and how large it does appear to be may be judged by holding up some object in the hand and placing it, as it were, side by side with the moon. I have often asked my friends' opinions, and have received replies unanimous in their great incorrectness, a dinner plate or a crown piece being generally the two extremes of maxima and minima. The truth is that the object which, held up in the hand and compared with the moon, would appear the same size, is neither of these—it is far smaller (a dinner plate would be as large as seven or eight thousand moons); it is a small pea. If a pea be stuck on a pin and held at arm's length it would entirely hide the moon from view!

I think I have shown how deceptive are appearances, and the moral I would draw is:—Before introducing a moon or a figure or any object into a picture, think well over all the bearings between appearances and realities, and to aid in doing so I believe the notes I have written will be of some service.—G. WATMOUGH WEBSTER, F. C. S., *in British Journal of Photography.*

IMPROVEMENTS IN PHOTOGRAPHIC LENSES.

By FREDERICK VON VOIGTLANDER, Brunswick, Germany.

SYMMETRICAL photographic lenses constructed according to my invention possess a considerably greater illuminating power and greater depth of focus than any other of the existing symmetrical constructions. These advantages have been obtained by the peculiarity of their construction, founded on calculations, but especially by the adoption and application of an optical principle not considered hitherto.

In every photographic lens two different kinds of rays come into action, namely, the optical or visual rays, and the chemical (not visual) rays; and from this point of view also

NEW VOIGTLANDER PHOTO-LENS.

two different pictures are obtained, namely, the optical or visual and the chemical picture.

In all photographic lenses hitherto constructed the optical picture was treated upon the same principles as the chemical; but as both kinds of rays have evident differences regarding their action, it has been my study and endeavor to make the chemical picture—which, in fact, is the only one coming into operation when making a photograph—as perfect as possible, even by somewhat injuring the visual picture.

I have fully succeeded in this respect by employing as material a flint glass of very great specific gravity and great refracting power, such as has never been used before for photographic lenses. By this means I am enabled to over-correct the visual picture—that is, give an overplus to the blue spectral rays; thus the chemical picture (the useful one in photography) is brought to that perfection which my new lenses possess. Also by this same means I am enabled to shorten the combined focus of this construction, so as even to obtain a proportion of six to one between the focus and aperture, and from this important circumstance, according to the laws of optics, the lenses derive great illuminating power.

The drawing represents a vertical section of a symmetrical photographic lens constructed according to my invention. It consists of two exactly symmetrical object glasses. Both object glasses are exactly identical, and consist each of two lenses (menisci); the object glasses are so placed that the concave sides face each other. The lens A consists of heavy flint glass, the index of refraction being = 1·655; of the other, B, the refracting index is = 1·55.

The combined focal length of such a system being supposed to be ..... = 1·000
The aperture of the object glass is..... = 0·666
The ratio of the curvature for the radius r^1 = 0·208
" " r^2 = 0·100
" " r^3 = 0·100
" " r^4 = 0·293
The distance between both systems, C ... = 0·2.

The surfaces r^1 and r^4 are exactly identical, and cemented together with a permanently transparent cement. A central stop, allowing the instrument to be used with full aperture, is placed between both systems, and a number of smaller diaphragms are furnished to provide for all required purposes.

Having thus described the nature of my improvements in symmetrical lenses for photographic use, and the manner of their construction, I would have it understood that I claim—

First. The manufacture of such lenses in which the differences of the visual and chemical picture are profited of to render the chemical (useful) picture as perfect as may be, and also obtain a considerably increased illuminating power with great depth of focus, substantially as above described.

Second. The construction of symmetrical lenses for photographic uses with the parts formed of the densities and curvatures, substantially as above described.

The above, when reduced to ordinary photographic language, must be held to mean that the lens is one of the same form as that which in our Almanac for 1870 was described, and illustrated by a diagram, as the well-known "rapid rectilinear." From this it differs in being made of dense flint glass instead of ordinary flint and crown.

By making use of a dense flint it is undoubtedly possible to increase the aperture—a fact that was specially pointed out by Mr. J. H. Dallmeyer, at a meeting of the London Photographic Society during the same month in which the Almanac above alluded to was published; but this advantage, in the estimation of that gentleman, was purchased at too great a price, namely, the deterioration of the glass of which the lens was constructed. Presuming that Herr Voigtlander has had his attention directed to the interesting researches made by Mr. Gaffield, of Boston, with respect to the changes that certain descriptions of glass undergo after an exposure, more or less brief, to light, and in virtue of which a dense flint glass after a short time acquires a decided yellow color, we further presume that the glass he employs in the construction of his lenses differs from any hitherto employed for this purpose in not being affected by light—a point which, not being mentioned in the specification, we can, however, only guess at.

A special feature claimed by the patentee, and one possessing interest from a scientific point of view, is that in which he boldly takes the "bull by the horns" and directs attention to the non-coincidence of the chemical and visual foci, to which he attaches much importance; for he says in the provisional specification—"I construct the lens so as to be over-corrected and somewhat imperfect for the visual picture, in order to obtain the chemical picture as perfect as possible. This I am enabled to do by making one of the glasses of each lens of a symmetrical double combination lens from a glass of greater density than has ever before been used in the manufacture of photographic lenses." On this point of the invention we may here observe that many photographers in this country have ever displayed a decided antipathy toward lenses possessing such a distinction between the two foci; while others, conceiving that by leaving the visual focus "to take care of itself" a greater number of the chemically-active rays might be brought to a focus together, have given their preference to lenses in which the chemical and visual focus did not coincide.—*British Journal of Photography.*

RAPID EMULSIONS.

MR. H. G. INSKIPP, of England, says: "The process I use is the bromide of zinc, *unwashed* collodion, with *slight* excess of silver, without preservative and without substratum, unless a slight polish with powdered talc can be called a substratum.

Perhaps my plan of correcting the emulsion may from its simplicity be of use to some: For four ounces of emulsion take three and a half ounces of the bromized collodion, and add to it in the usual way the silver for four ounces. This will *ripen* rapidly and soon pass into the foggy stage. Then add the other half ounce of collodion, a little at a time, testing till the fog *just* disappears, when it will be in the most sensitive state.

In developing I use a modification of Newton's sal-soda formula; and here, again, my aim has been simplicity:

Common washing soda.....	1 ounce.
Bromide of ammonium.....	25 grains.
Strong liquor ammonia.....	½ ounce.
Water.....	8 ounces.

Flow over sufficient to cover the plate; add to it a little dry pyro and flow again, when the image will rapidly appear; add a *little* more pyro, if needed, and wash off *directly all the detail is out.* Fix, wash, and dry. If not intense enough when dry, moisten it under the tap and proceed to intensify with pyro and silver, when (at least with my plates) any amount of intensity can be obtained.

The plates I am now preparing are more sensitive than wet, and much easier to develop."

SUSPENSION, SOLUTION, AND CHEMICAL COMBINATION.*

By WILLIAM DURHAM, F.R.S.E.

SOME time ago I made some experiments on "suspension of clay" in water, in acid, and in saline solutions. These formed the subject of several communications to the Royal Physical Society of Edinburgh, and an abstract was afterward published in the *Chemical News.* I shall describe some of these experiments as an introduction to this paper:

1. *Clay in Water.*—A few grains of fine white clay were stirred up in about a pint of pure water, in a glass jar. The time which the water took to clear, and the clay to deposit itself in the jar, was noted, and found to be about thirty hours.

2. *Clay in Acid Solutions.*—To a similar quantity of clay and water were added a few drops of acid, and the time of clearing again noted. In this case the time was from half an hour to one hour, according to the quantity of acid used.

3. *Clay in Salt Solutions.*—In place of acids, salts of various kinds were added to the clay and water, and the effect in every case was to shorten the time of precipitation of the clay, according to the kind and quantity of the salt used.

In endeavoring to ascertain the cause of these phenomena I was led to experiment on various solutions, and obtained results which appear to me very interesting, and to open up a line of research likely to lead to important results as to the laws of solution and chemical affinity. The following are the more important facts as yet determined:

1. NaCl and HCl.—To a saturated solution of sodium chloride was added strong hydrochloric acid. Salt was rapidly precipitated on each addition of acid. This action is usually described as sodium chloride insoluble in hydrochloric acid, but the mode of action does not seem to have attracted much attention. The following experiments throw some light on the matter:

2. $Na_2SO_4 + 10H_2O$ and HCl.—To a saturated solution in water of sodium sulphate was added strong hydrochloric acid. *Anhydrous* sodium sulphate was precipitated. The precipitate was immediately dissolved on a further addition of hydrochloric acid. In this case it cannot be said that anhydrous sodium sulphate is insoluble in hydrochloric acid, as it easily dissolves in excess of acid. Th action seems analogous to what occurs when ammonia is added to a zinc salt. Zinc oxide is first precipitated, and then dissolved again as excess of ammonia is added. The next experiment makes the action more apparent.

3. Crystals of $Na_2SO_4 + 10H_2O$ and HCl.—Strong hydrochloric acid was poured over some crystals of sodium sulphate. The crystals were rapidly broken up, the water uniting with the hydrochloric acid, while the anhydrous salt was left undissolved. As in No. 2, however, on the addition of excess of acid the anhydrous salt was at once dissolved.

4. $CaCl_2$ and HCl.—To a saturated solution in water of calcium chloride was added some strong hydrochloric acid. No action was apparent. As calcium chloride has a great affinity for water, I concluded that the affinities were balanced in the two solutions, and therefore there was no apparent action. To prove this, I added to the hydrochloric solution some fragments of solid calcium chloride, which, as anti-

* From a Paper read to the Royal Society of Edinburgh, January 21st, 1878.

cipated, rapidly dissolved with effervescence, expelling hydrochloric acid gas copiously.

5. A weighed quantity of solid calcium chloride was dissolved in a measured quantity of water, and the rise in temperature noted: this was 15° F.

6. The same quantity of solid calcium chloride was added to strong hydrochloric acid, and the rise in temperature also noted: this was 6° F., being a difference of 9°, accounted for, no doubt, by the vaporizing of the HCl gas expelled in the latter case.

7. NaCl and $CaCl_2$.—Calcium chloride, both in saturated solution and solid, was added to saturated solution of sodium chloride, and in both cases the sodium salt was precipitated, the calcium chloride taking its place in solution.

8. HCl and H_2SO_4.—Strong sulphuric acid was added to strong hydrochloric acid, when the latter as gas was expelled with effervescence.

9. $CaSO_4$, HCl, and H_2SO_4.—Strong sulphuric acid was added to a saturated solution of calcium sulphate in hydrochloric acid. Calcium sulphate was precipitated and hydrochloric acid gas expelled. I next looked for two solvents which would dissolve the same substance and yet precipitate it when mixed. These results I found with sulphuric acid, water, and calcium sulphate, thus:

10. Two solutions (saturated) of calcium sulphate, one in water and one in sulphuric acid, were mixed. Calcium sulphate was deposited on cooling.

11. $CaSO_4$ in Water, and H_2SO_4.—To a saturated solution of calcium sulphate in water, sulphuric acid was added. Calcium sulphate was precipitated on cooling.

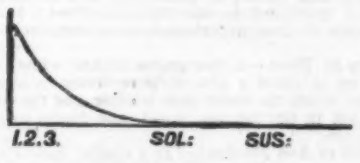
12. $CaSO_4$ in H_2SO_4 and Water.—To a saturated solution of calcium sulphate in sulphuric acid, water was added. Calcium sulphate was precipitated on cooling.

Three experiments, similar to Nos. 10, 11, and 12, were performed, only substituting clay in suspension for calcium sulphate in solution, and the results were similar. Clay in strong sulphuric acid was suspended nearly as long as in water, but on mixing the liquids, or on adding sulphuric acid to water, or water to the sulphuric acid, the precipitation of the clay was greatly accelerated. Experiments 10, 11, and 12 seem to indicate that there is a point on one side of which water affinity is in excess, and on the other side sulphuric acid affinity.

I hope to extend these experiments to other substances than those already operated upon, and to enter more minutely into the various phenomena. So far as they go, however, they seem to point to certain conclusions which are interesting and suggestive:

(1.) *There seems to be a regular gradation of chemical attraction, from that exhibited in the suspension of clay in water up to that exhibited in the attraction of sulphuric acid for water, which we call chemical affinity.* The attraction between water and clay is neutralized by the stronger attraction between water and salts in solution. The latter, in its turn, is neutralized by the attraction between water and hydrochloric acid, which *almost* reaches the strength of a definite chemical compound. Then, finally, we reach water and sulphuric acid, which neutralize all the foregoing attractions and form more than one definite chemical compound.

(2.) *That chemical combinations, solutions, and suspension differ only in degree, and are manifestations of the same force and definite chemical compounds, are just the points where the affinity exerts force enough to hold an exact number of atoms with a certain strength.* Chemical affinity should be studied in this connection as a regularly increasing force represented in the usual way by co-ordinates. For example, sulphuric anhydride, SO_3, might be represented by some such as the following—



where 1 would represent the force by which 1 molecule of H_2O was held; 2 and 3 the force by which 2 and 3 molecules of H_2O were held. Sol.: the strength of attraction between SO_3 and H_2O, which prevents solution (say) of $CaSO_4$; and Sus.: the strength which prevents clay being held in suspension.

(3.) *The attraction of chemical affinity is not, in every case at least, exhausted when a definite compound is formed, but has sufficient power left to form solution or suspension compounds.* Thus calcium sulphate is a definite chemical compound, but it still possesses sufficient affinity for sulphuric acid to enter into solution with it. This view might explain the researches of M. Stas on atomic weight. If he be correct he proved that Prout's law—that "the atomic weights of the elements are simple multiples of that of hydrogen"—is not correct, though very nearly so, the differences being very small. If it be true that the attraction of affinity is not entirely exhausted in a definite compound, but that there is a fraction of it, so to speak, to spare, we should only find Prout's law to hold good if we could analyze 1 molecule of any compound but as in any analysis we can make there must be many molecules, each atom of these molecules having a fraction of its affinity for another atom to spare, these fractions would unite and hold in combination an extra number of the other atoms—not so firmly, perhaps, but still firmly enough to make the whole appear a definite compound on analysis; and this would affect the calculation for atomic weight. Thus suppose 2 atoms of Cl = 71 combine with 1 atom of Ca = 40, and still have 1-100th part of affinity to spare, then 200 atoms of Cl would take up 101 atoms of Ca, and from this analysis we should make the atomic weight of Ca not 40, but 40·4.

(4.) *If chemical combination and solution are due to the same force, then solution will loosen the combination by spreading the affinity*, and possibly there may be a rearrangement of the soluble and solvent analogous to what is known to take place when two salts, having different acids and bases, are mixed. Thus, it appears to me, a drop or two of sulphuric acid added to a pint of water spreads its affinity equally through the whole pint of water; and this is the force which compels the water to drop or precipitate the clay. It further seems to loosen slightly the affinity of the H and O in the water, so that they are easier separated, as shown in the conduction of electricity. As more acid is added the effect is increased, until a point is reached where the quantity of water is no longer sufficient completely to neutralise the affinity of the sulphuric anhydride, which is shown by such phenomena as solution of $CaSO_4$ and increased resistance to electric conduction, because the SO_3 has begun to draw to itself more strongly the elements of the water, as its action is now concentrated on a smaller quantity.

If these views prove to be correct, many phenomena at present obscure would be readily explained.

MANUFACTURE OF IODINE, BROMINE, NITRATE OF POTASH, AND SODA.

By THORWALD SCHMIDT, Aalborg, Denmark.

THE ashes of the seaweed—kelp—are washed according to the method given by Shanks, St. Helens, near Liverpool, for which purpose is used a series of large square vessels, over whose real bottom is applied another double bottom furnished with holes. From the space between the real bottom and the one with holes a pipe leads into the upper part of the next vessel; from the bottom of the latter a pipe like the former leads into the next, and so on. In this manner the fresh water always meets the most washed ashes, and the fresh ashes the strongest solution. The exhausted ashes may be used as excellent manure, or may still more profitably be sold in places where the phosphoric acid therein contained may in any other manner be of use.

The solution, having been concentrated as much as possible, is to be tapped into a reservoir large enough to hold the quantity of liquor containing chloride of calcium sufficient to transform the sulphates contained in the solution into hydrated sulphate of lime and chloride combinations.

The liquor of chloride of calcium is to be had in large quantities as a refuse from the manufacture of ammonia-soda. At first we must ascertain how much chloride of calcium is requisite, and then it is added gradually under continual stirring, until no more sulphate of lime precipitates; but of course no more chloride of calcium must be added than is strictly needful.

When the liquor, after a careful mixing, is left to itself, the greatest part of the sulphate of lime will soon deposit on the bottom of the vessel, but a part of it finely divided will still continue to float in the liquor while another part of it dissolves in it.

A small distance above the bottom of the vessel is attached a pipe in connection with a suction and forcing pump; when the liquor has become tolerably clear, the pump is worked, and the fluid is forced through a filter-press into a similar reservoir. The fluid is now quite clear, and of the sulphuric salts only the dissolved sulphate of lime remains.

Now we take a sample of the solution, test how much of the chloride of barium is needed to precipitate the sulphuric acid in the dissolved sulphate of lime, as sulphate of baryta, weigh the necessary quantity of chloride of barium, and dissolve it in as much of the solution as needful. The latter solution is poured into the vessel, and the liquid is well stirred, that the mixture may be as complete as possible.

Another pump, likewise with a pipe in connection with this reservoir, again presses the liquid through a second filter-press into the third reservoir.

When a large quantity of sediment of sulphate of lime is gathered in the first reservoir, the latter is cleared, and this sulphate of lime, as well as that from the filter-cloths, is to be well washed, and the washing is used again for dissolving the kelp.

We have of course now—

Precipitated sulphate of lime = *Annaline*, or pearl-hardening.

Precipitated sulphate of barytes = *Blanc fix*, or permanent white; and all the sulphates in the fluid transformed into chlorides.

We now examine how much of iodine and bromine is contained in this clear liquid, and put so much nitrate of lead to it that we are sure of a small surplus so that a little chloride of lead may be precipitated. The liquid is to be stirred well, that a careful and intimate mixture may take place, and this stirring is to be continued until the lead solution is all poured in.

As soon as we are sure of a complete mixture, the pump which is in connection with this vessel is worked, and the liquid is, as in the foregoing operation, forced through a third filter-press into a fourth reservoir. We have then, when the vessel is employed, all the iodine and bromine with a little portion of chloride, as iodide, bromide, and chloride of lead on the filter-cloth. In this manner all loss of iodine and bromine is prevented, which, in the manner generally adopted, can only be attained through careful and repeated washings, and a considerable quantity of fuel and time is saved. The iodide and bromide of lead is then worked into such combinations as are required.

The liquor from this operation contains, as may be understood, besides the trifling quantity of nitrate from the nitrate of lead, all the potash, soda, magnesia, and lime combinations as chlorides. To this is put some dirty carbonate of soda, such as sweepings from the soda works, to precipitate the magnesia and the lime. Having stirred the liquid in the vessel for some time, we again let the liquor, by means of a pump, pass a filter-press, and in this liquor we dissolve as much nitrate of silver as is needful to transform the remaining potash into nitrate of potash, after which it is treated in the manner generally used in manufacturing of nitrate of potash. Still, it is advisable to apply the filter-press before the beginning of the evaporation.

The salts left as a refuse by this mode of manufacture are excellent materials for the manufacture of soda by the ammonia process, which has been proved long ago by practice, and it is, therefore, after the experience I have had, my firm conviction that these industries are in a high degree adapted to be combined. Either we wish to carry on the whole combined business, or only the manufacture of soda and nitrate of potash, so much the more as we may work proportionately as profitably in a small as in a large manufactory of soda, of course within certain limits. We are of opinion that such a manufactory must not produce less than 20 or 30 cwts. of soda per day, and the furnishing will, besides the cost of buildings and boilers, amount to about £1,600.

In beginning such an enterprise on a smaller scale we have the advantage, with proportional small means, to be able to surmount the technical difficulties, exercise the workmen, arrange the circumstances connected with the sale, and are always able to extend the works.

Where seaweed is to be had in large quantities on the coast, or where there is already a manufactory of nitrate of potash, or where rock salt or salt wells are near, and coals and limestone may be had tolerably cheap, there a manufactory of ammonia-soda will be carried on with profit.

For further explanation I shall only add that 180 to 200 parts of salt, 105 parts of good coal, 5 parts of sulphate of ammonia, 23 parts of coke, 1 part of sulphuric acid, and 81 parts of limestone are the raw materials for 100 parts of refined soda, 95–97 per cent equal to about 270 parts of crystal soda. I shall willingly—if such is wanted—give the details of such an establishment.

The manufacturing itself of ammonia-soda is, with appropriate apparatus, by no means more difficult than any other mere chemical manufacturing business; and it has this good point, that no persons will easily understand what takes place unless they are intimately connected with it, or the operation of the apparatus is explained to them, nor can the workmen give any particular information; it is thus possible, with a little care, to keep this interesting manufacture a secret to the public for a long time.—*Chemical News.*

COAL AND ITS COMPONENTS.

By Prof. BARFF, M. A.*

THE lecturer described briefly the supposed formation of coal, and showed specimens which proved its vegetable origin; he then proceeded to notice the different kinds of coal, and explained how they differ from one another in composition. The next subject touched upon was the method by which chemists determine the composition of complex bodies. A brief description was given of what is called proximate analysis; and, in illustration of this, an experiment was performed, which consisted of heating some fragments of coal in a hard glass tube. The products of the decomposition being passed through various receivers, the results produced showed water and coal tar in the first receiver, and in the second the blackening of acetate of lead solution proved the formation of sulphureted hydrogen, by the destructive action to which the coal had been submitted, thereby showing the presence of sulphur in coal. The gases which issued from the delivery tube were burnt. He next explained what was meant by ultimate analysis, and illustrated this experimentally by burning a piece of coal in a hard glass tube, and leading, by means of an aspirator, the products of combustion first through a condenser and then through a solution of lime in water; in the first vessel water was condensed, and in the second the lime water became turbid, showing the formation of carbonic acid gas. Toward the end of this experiment pure oxygen gas was passed through the tube containing the hot coal, and the action became much more vigorous, and this afforded a place for an explanation of the work which oxygen performs in nature. The general properties of carbon were next explained, and its occurrence in nature in different forms mentioned. The general tests for carbonic acid gas were shown; how it always extinguishes a light, and its action on lime water, rendering it milky by the formation of chalk or carbonate of lime. The existence of carbon in organic matters was shown by acting on a strong solution of sugar by concentrated oil of vitriol, the sugar being decomposed and abundance of carbon being set free, which frothed up and filled the large glass vessel in which the experiment was performed. It was also shown that carbonic acid is breathed out by animals. After this portion of the lecture was concluded, a series of experiments were performed by Mr. Orchard, of High street, Kensington. This gentleman is largely engaged in condensing gases, especially nitrous oxide or laughing gas, which is used in "painless dentistry." Professor Barff explained how it is that gases can be brought into the liquid condition, and the experiments of Mr. Orchard illustrated this explanation; they consisted first in allowing the escape of liquid carbonic acid from a strong iron vessel, the escaping gas being tested by lime water to prove that it was carbonic acid; it was then allowed to rush out in a long stream, which from its whiteness was clearly visible; next it was allowed to rush into a metal receiver, and when the receiver was opened, a ball of solid carbonic acid was turned out, which looked exactly like a snow ball. Some of this solid was put into a test tube, and the gas, slowly escaping, extinguished a lighted taper. Mercury was also frozen by a mixture of solid carbonic acid and ether; and the lecture concluded with some experiments with liquid laughing gas, which was exhibited to show a gas in the liquid state, for it is difficult to show carbonic acid in this condition in the lecture-room. The next lecture will treat of hydrogen and some hydrogen compounds obtained from the destructive distillation of coal.

*Journal Society of Arts.

COPPER WITH THE AID OF WASTE PRODUCTS.

By HUGH M. WILSON.

THE burnt ore obtained from the pyrites kilns is treated with waste chloride of manganese liquor from the chlorine stills, which is pumped on to a layer of the ore several successive times. A large portion of the copper contained in the ore is thus extracted by means of the free acid always present in the still liquor. The chloride of copper solution is then run on to a sufficient quantity of soda waste to convert the whole of the copper into sulphide by means of the sulphureted hydrogen disengaged from the waste. The manganese and calcium salts now in solution can easily be separated from the sulphide of copper, which is thrown on to a drainer, well washed, and afterward heated on iron plates in order to convert it into sulphate of copper, which is then treated with boiling water and allowed to crystallize.

At chemical works where the chloride of manganese liquor is treated according to Weldon's method a modification of the above would be necessary, as that liquor could not in that case be employed. The burnt ore might be ground fine and calcined with common salt in a blind roaster furnace, and then, after separating the copper chloride by lixiviation, the treatment continued as above described.

The pyrites used in charging the burners for the above process should be treated in the following manner:

The large lumps are crushed in a stone crushing machine, and the dust and smaller portions sieved away from the larger pieces, which are then ready for use. The dust and smaller lumps are ground into a paste with water, spread on iron plates, and allowed to dry at a gentle heat. Before the mixture of pyrites and water is dry it can be marked out into the required size for charging the kilns, viz., about two inches square. The sulphur ore thus prepared has the advantage of being uniform in size, of burning spontaneously as it were, no additional heat being required to decompose it when once the burners are red hot, and of costing no more to obtain it in that form than by adopting the ordinary process of breaking the large lumps with hammers.

A modification of the process described is being carried on on a small scale; but it is not generally known, or it would be extensively adopted, owing to the simplicity and efficiency of its nature.—*Chem. News.*

THE LIQUEFACTION OF THE GASES.

THE close of 1877 has been marked by a chemical discovery of the highest interest. Oxygen, hydrogen, nitrogen, and atmospheric air have all been condensed to liquids partially, perhaps also to solids. There is, therefore, no longer such a thing as a permanent, incondensable gas, and the distinction formerly drawn between true gases on the one hand and vapor on the other falls away. It was once supposed that solidity was an essential property of some bodies, and gaseity of others. We knew, of course, that most solid bodies could be liquefied by the application of heat, and by a still stronger heat could be converted into a gas, or vapor, which, on cooling, would return first to the liquid state and then even to solidity. Many of the so-called true or permanent gases were liquefied, or even solidified, by Faraday, Bussy, Nieman, and others. Still hydrogen, oxygen, and nitrogen, and that mixture of the two latter known as common air, seemed to resist the joint action of extreme cold and powerful mechanical pressure. By the aid of simple but ingenious contrivances, M. Pictet, of Geneva, and M. Cailletet, of Paris, have been able to expose the gases to a temperature of —140° C. = 252° Fahr. below freezing point, or 220° below our ordinary zero, and to subject them, when at this temperature, to the pressure of 500 atmospheres. We have now, therefore, not merely theoretical conclusion, but actual matter of fact proof, that the difference between the three aggregate states of bodies—the solid, the liquid, or the gaseous—is due, not to anything in their own nature, but merely to the temperature and the pressure to which they happen to be exposed. Heat platinum sufficiently and it becomes a gas. Perhaps this may be its condition in the atmosphere of some of the more intensely incandescent stars, such as Sirius, if, indeed, it is not altogether decomposed. Cool and compress oxygen and hydrogen sufficiently, and we may have permanent solids.

We may be asked, What is the practical use of all this? At the present moment we cannot reply to this question; but it is very rare for a fact, when once established, to remain barren. Let chemists have, at least, time to examine what properties these elements—oxygen, hydrogen, and nitrogen—display in their liquid or in their solidified state. We know that the gaseous state is not the most favorable for combination. It may, perhaps, happen that these discoveries may point the way to the combination, on an industrial scale, of nitrogen with hydrogen, or with oxygen. Either of these results would be the grandest triumph of technical art yet known, as it would enable the quantity of food produced by the earth to be increased to an almost incalculable extent. It will also be extremely interesting to find whether hydrogen when solidified has the character of a metal, as theory seems to indicate.—*Chemical Review.*

SODA AND POTASH FROM CHLORIDES.

By M. J. BOHLIG.

THIS process depends on the use of oxalate of magnesia. This salt is digested with an equivalent quantity of common salt and of muriatic acid Chloride of magnesium remains in solution while the acid oxalate of soda separates out in crystals. This oxalate is washed in a little water, and placed in an autoclave along with corresponding quantities of carbonate of magnesia and of water. Carbonic acid is given off, and when it has expelled the air, the autoclave is shut and the contents stirred with an agitator. The pressure, which at first reaches two atmospheres, soon falls again. The operation is then terminated, and the products of the reaction consist of a concentrated solution of bicarbonate of soda, which may be easily removed by decantation from the compact crystalline oxalate of magnesia. The solution of bicarbonate is boiled with magnesia, obtained by decomposing the chloride of magnesia by heat. Carbonate of magnesia is precipitated, and neutral carbonate of soda remains in solution.

Or the bicarbonate of soda may be at once treated with magnesia instead of employing carbonate of magnesia. In this case the mixture is introduced into horizontal casks fitted with agitators. The upper half of the two opposite ends of the casks is pierced with holes, permitting the introduction of cooled furnace-gases, which pass over the surface of the mixture and supply the necessary carbonic acid.

To prepare the oxalate of magnesia the author precipitates sulphate or muriate of magnesia with a solution of oxalate of potash, obtained by the action of potash upon wood, and purified in the ordinary way. To obtain pure oxalic acid from the oxalate of magnesia, the author puts this salt along with water in wooden vats, heated by steam, and adds muriatic acid till the salt is dissolved. On cooling, oxalic acid crystallizes out.—*Dingler's Journal.*

ICE-HOUSE AND REFRIGERATOR.

By JOHN TAYLOR.

HOUSES built on this plan are lined throughout the inside with sheet iron. There is a layer of felt nailed to the sides, ceiling and floor of the room, and on this is nailed the sheet iron. It is then painted with two heavy coats, it being the aim to fill up all joints and seams with the paint. But as the tin and felt do not render the room absolutely air-tight, I am of opinion that it can as well be dispensed with. It might save some ice if the seams were all soldered. The layer of cement, asphaltum or gas tar, which should cover the ground below the joists, is to protect the room from the moisture and warmth of the earth. Above this layer should be about 30 inches of dry sawdust or turners' shavings, well packed up to the level of the top of the joists.

The drainage from the ice is carried off by a series of V-shaped tin or iron troughs, which run between the joists, all of which carry the water to one point, where it is conveyed outside by a trap pipe. These troughs reach over to the center of the top of the joists, and are soldered together, so that no water will drip on the floor below. It will be seen that in this plan there is no sawdust or other preservative in contact with the ice, and that the air of the room circulates around and over the ice. As long as the temperature of the goods stored is above the temperature of the room, there will be a gentle draught around the mass of ice, and of course all the moisture in the air, vapors and odors from the goods will condense on the ice, and pass off, so that you can keep milk, cream, butter, fruits and meats all in the same chamber without danger of injuring the flavor of either. The atmosphere of the room is always dry, sweet and pure.

The features of this plan can as well be carried out by arranging a room inside of another building, as in the case with the one I described in a former article.

I should have explained before that the ice does not rest directly on the joists; but there is a bed of oak lath, about 1½ by 3 inches, laid across the joists, about 4 or 5 inches apart, on which the ice is laid. I would further suggest that another cold chamber can as well be had by making a cellar under the one shown, with a lattice floor between them. It would be necessary to finish the sides and bottom of this cellar in the most complete manner, as above described. At the entrance to the store-room there must be a vestibule, either inside or outside, as space or circumstances may direct. If outside, the walls should be thick and the door very heavy. The doors, both inside and outside, should be fitted with rubber, so as to close perfectly tight, and both doors must never be opened at the same time. This vestibule should be large enough to contain a fair wagon load of goods, so that if you are receiving a load of stuff, you are not required to stop until all is in the vestibule and ready to

Refrigerating House.

store. This house only needs filling once a year. The temperature will range from 34° in winter to 36° in summer, and will preserve fruit perfectly from season to season. The opening for putting in the ice, shown just under the pulley in the cut, has two doors, with a space between; each door a foot thick. The window in the cold room has three sets of sash, well packed, or cemented. The walls are 13 inches thick, lined with 17 inches of sawdust. Thirty-six inches of sawdust are put on the floor over the ice. The building shown is 25 feet square, inside measure, and 22 feet from floor of cold room to ceiling over the ice. The ice-room is 12 feet high, and the cold room 9 feet. Pillars are required under the center of the ice.—*Country Gentleman.*

HOUSE GRAPES.

WE have now a very extensive array of grapes. Nearly one and a half hundred varieties or kinds are described in Dr. Hogg's "Fruit Manual," and the lists of nurserymen are much more prolific in grapes than they were a few years ago. New (or alleged new) varieties have made their appearance, and some, though backed up by first-class certificates, have proved of questionable merit, it being doubtful if any new varieties are equal to Black Hamburgh and Muscat of Alexandria for general purposes. I have no hesitation in saying that for a majority of growers they are the grapes *par excellence.* Go where we may we find a preponderance of Black Hamburgh; it is the most prominent of black grapes. The Muscat of Alexandria is grown by every one commanding heat; it, next to the Black Hamburgh, is the most extensively cultivated grape. Not the least that can be said in the favor of those grapes is that they succeed with every one, if able to grow a grape at all. It may be urged that the Muscat of Alexandria is a bad setter; but compare it in that respect with some of the newer kinds grown in the same house, and we shall find that there is not nearly so bad a setting nor so many stoneless berries in the Muscat of Alexandria as the others, Mrs. Pince and Black Muscat being great sinners in that respect.

But much as I like Black Hamburgh and Muscat of Alexandria, they cannot be depended upon for a supply of grapes from December to April. During some seasons they keep very well up to Christmas, but not always, and I do not think it judicious to rely upon them after November; therefore, we are under the necessity of a third, and that, as I have found it, is Lady Downes. I have seen fruit of this grape hanging quite fresh in April, while it is well known that grapes keep quite as well cut with a portion of shoot inserted in water in a dry room as on the vines; indeed, very much better than in a leaky vinery. With the three kinds, viz., Black Hamburgh, Muscat of Alexandria, and Lady Downes, we need have no fear of not maintaining a supply of grapes the year round, and it may be accomplished by a house of Black Hamburghs to ripen in late April or early May; a second of Muscat of Alexandria, to ripen in June or early July, having a few Black Hamburghs in the same house, which will be ripe a month earlier than the Muscats; and a third house of Muscat of Alexandria and Lady Downes, planted alternately, to ripen in September, the Muscat being good until near Christmas, sometimes later, when Lady Downes will come in and continue until May.

Another such trio is not to be found in grapes. Why have more kinds? Variety is wanted. Many know not what it means. A vinery planted with as many vines of different kinds as the house can accommodate, instead of but one, or at most, two kinds, means, as I have invariably seen and experienced, some success with no little failure. My advice to beginners is, do not plant a dozen sorts of grapes if one will serve the purpose intended, unless it be specially proposed by the proprietor. Quantity and quality are combined in the sorts mentioned, and they generally afford satisfaction alike to grower and consumer.

Variety being requested, and I confess to admitting its charms, let it be sought in kinds that are likely to afford satisfactory results, inasmuch as there is no need to admit doubtful kinds, we having so many really good, tried grapes awaiting acceptance I may note a few for different times of the year, and shall endeavor to name as few as possible consistent with the object in view.

Early vinery—Mill Hill Hamburgh, Black Hamburgh, and Black Muscat (Muscat Hamburgh) worked on Black Hamburgh. Of whites—White Frontignan, Golden Hamburgh, Buckland Sweetwater, and Foster's Seedling—representatives of the Hamburgh, Muscat, Frontignan, Sweetwater, and Muscadine grapes. A house of those kinds may be forced to afford grapes in April onward, they being equally select for ripening in June.

Second vinery or mid-season—Black Hamburgh, Black Prince, Frankenthal, Madresfield Court, Muscat Trovereu, and Foster's Seedling. Muscat of Alexandria is at this season indispensable. It is grown in a house or division by itself, having a good black companion in Mrs. Pince and Black Muscat of Alexandria.

Late vinery—Alicante, Lady Downes, Gros Colman, West's, St. Peter's, Bowood Muscat, White Tokay, Mrs. Pince, Gros Guillaume, and Trebbiano. Calabrian Raisin and Syrian may be added, if more whites are desired. A house of Gros Colman, Trebbiano, Gros Guillaume, and Syrian would produce a sensation; but the great desideratum is a suitable black companion for Muscat of Alexandria, there being none at all worthy of the position except Black Hamburgh, they, unfortunately, in the same house not ripening together; also a white companion is equally wanted for Lady Downes.—A. G. P., *in Journal of Horticulture.*

THE CHINESE YAM.

A CORRESPONDENT of the *New York Evening Post* writes from Indiana in favor of the more general cultivation of the Chinese yam, which he has grown for fifteen years and found to be his most profitable crop. The following extracts contain the substance of his communication:

Their culture is simple. Get a soil that is moderately dry, deep, and rich, plant the tubers, and the largest portion of the work is done. They increase naturally from the small tubers that grow on the vine just above each leaf. These should be saved in the fall, and kept during winter where they will not freeze, as freezing injures them, and planted in the spring as soon as the ground gets warm, the surface being left level when planted. The first year they will need to be hoed a few times to keep the soil loose and weeds down. They are perfectly hardy and stand in the ground all winter, and grow again when spring comes, increasing in size for a number of years. After the first year they require very little attention; simply keep the weeds hoed off or mowed down, as you prefer.

The product per acre would vary according to the number of years they have been left to grow, the kind of soil they are in, and the distance apart the tubers were planted; if in the best of soil, with three years' growth, and with tubers planted eight inches apart each way, we could safely calculate on getting six and a quarter tons of yams per acre.

A few years ago I was digging in an old bed where yams had been left to grow for several years, and beheld such a sight! The ground was literally full of roots measuring from one and one half to two feet in length and from an inch and one half to two inches in diameter at the largest end, and this, too, where the soil was not more than eight or ten inches deep.

In taste there is very little difference between the Chinese yam, when properly cooked, and the Irish potato, although the yam is much whiter and somewhat finer grained.

The vine is ornamental, the leaf being heart-shaped, edged with scarlet, and very pretty. A few tubers may be planted near doors and windows, and the vines trained over and about them, making a very pleasing effect. The roots, being hardy, stand in the ground all winter, and grow again each returning spring.

They have no insect enemy, and drought affects them but little, as they root so deeply. There is no necessity of their being dug at any particular time in the year, only when wanted for immediate use. They are suitable for cooking at any season of the year. A person can plant enough of them at one time to supply his family for years, each year bringing him larger yams. For these reasons I consider them safer to depend on than the Irish potato, which has its enemies, and is so sensitive to a little freeze. I believe their proper cultivation would meet with success anywhere in the United States.

STATELY SEED PLANTS.

MR. W. KEMP has contributed an excellent article to one of the gardening magazines on the art of raising cheap stately plants from seed. The information will be especially valuable this month; and the writer has shown that for very little money some fine ornamental specimens may be introduced. Planted in moderate numbers and judiciously arranged, striking effects may be produced. Many broad leaved, tall plants, conspicuous for the beauty of their general appearance, may be raised with the aid of a hot bed in which to start the seed and a frame in which to harden the seedling. Stocks may thus be raised with moderate attention, and some may be propagated without the aid of glass. Two drawings are given in proof of the assertion, the first being the *Heracleum giganteum*, and the second the *Justicia speciosa*. The Acanthus, the Cannas, and the Cardoons will suggest themselves as noble types of beauty; fortunately their cultivation is within the limits of the strictest economy. The writer includes in his description a few medicinal plants which will be familiar. The *Eucalyptus globulus* attains a height of from six to ten feet during the season, while the *Nicotiana* recommends itself by the facility with which it can be raised and its handsome foliage. The *Nicotiana grandiflora purpurea* and *Nicotiana macrophylla gigantea* being among the best varieties.

Often we have had the pleasure of seeing the medicinal *Ricinus*, a most lovely plant, as a decoration in a crowded room, where its cool green foliage was in contrast with the glare of gaslight. It is far more attractive in its natural habitat, the garden; can be raised easily, and attains to large dimensions (six to eight feet high). All it wants is a friable and rather rich soil. *Ricinus Africanus*, with green foliage, and *Ricinus sanguineus* tri-color, with deep-red leaves and stems, are recommended. The *Daturas* may well come in for a word of praise, and the list is by no means exhausted. It is important in case of these rapid growers not to draw them up too quickly in the hot-house under glass. To change the subject, there is no much finer sight than that presented by a field of domestic well-grown rhubarb, when the green color merges into purple, and the sun shines upon it. As garden plants, both the *Rheum officinale* and *Rheum palmatum* are regal in their beauty.—*Chemist and Druggist.*

PROF. LEUCKART has just issued, in Berlin, the first part of his "Bericht über die wissenschaftlichen Leistungen in der Naturgeschichte der niederen Thiere" for 1872-76, the continuation of the reviews which he has hitherto been accustomed to compile at intervals in this department of zoology.

SCIENTIFIC AMERICAN CHESS RECORD.

(All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.)

PROBLEM No. 64. BY SAMUEL LOYD.

"Let those laugh who win."—First Prize, *Chess Monthly*, 1857.

Black.

White.

White to play and mate in three moves.

CHARLES H. WHEELER, OF ENGLEWOOD, ILL.

White to play and mate in 3 moves.
By R. H. SEYMOUR.

HOWEVER much the critics may favor difficult and complicated chess problems, they can never draw the popular taste of the great mass of chess players from the neat and pretty style which is so greatly admired.

Mr. Wheeler stands prominently among the number of composers who have the peculiar gift of creating these charming positions, and we have seldom if ever seen a crowded or complicated problem with his name attached, but have always found some pleasing feature connected with his compositions that repays the solver for his trouble.

Mr. Wheeler is a modern composer, whose advent dates since the publication of the *Chess Nuts*, but he is very prolific and a contributor to all of the leading chess columns.

He seems to have avoided tournaments, wherein so much encouragement is given to complex positions, and we have never known of his competing but once, when we took the liberty of entering the following of his compositions in the *Centennial*, without the knowledge of the author, and which will be found to contain some of the simple but pretty features which are characteristic of this clever artist.

ENIGMA No. .—By C. H. WHEELER.

White.—K on Q 8, Bs Q B 6 and Q Kt 4, Ps Q R 5 and Q B 3.

Black.—K Q R 3, P Q R 2.

White to play and mate in four moves.

CHESS MONTHLY PROBLEM TOURNAMENT OF 1857.

THIS little tournament was held over a score of years ago, but is still fresh in the minds of our problemists, owing to the number of times the problems have been republished and the tournament referred to. Prizes were offered for the three best sets of three problems, consisting of three four, and five move problems; also prizes for the best suicidal and conditional problems. But as these latter positions were all faulty there was no competition. Among the regular sets but two were found to be correct. Both prizes were therefore awarded to Samuel Loyd for the sets, "Let those laugh who win" and "A la mémoire de Szen," one from each set being given on our diagrams of this week.

SOLUTIONS TO PROBLEMS.

No. 58.—By F. W. MARTINDALE.

(The R on Q 2 should be black.)

1. R to K B 6	1. Kt x P
2. Q to K 4 ch	2. K x Q
3. Kt to B 3 mate.	

No. 59.—By S. LOYD.

1. Q to Q B 3	1. Kt to Kt 6 or B 7
2. Q to Q 4 or K 5 ch	2. K x R
3. R to B 2 mate.	

LETTER "Y."—By W. A. BALLANTINE.

1. B to Q 2	1. Any move
2. R mates.	

ENIGMA No. 25.—By EUGENE DELMAR.

1. K to Q B 3	1. K to Q 4
2. R to B 6 dis. mate.	

ENIGMA No. 26.—By W. A. SHINKMAN.

1. Q x Q Kt P	1. B to R 7
2. Q to Q R 8	2. Kt to B sq
3. Q x B mate (beautiful).	

SANS VOIR.

Since the practice of playing chess without seeing the men or board has become so general of late, a few remarks upon the subject may not be uninteresting to our readers.

It is commonly supposed that Philidor was the first who practiced this art successfully, but this is an error. The earliest account we have of blindfold playing is related of a Greek, named Joseph Tchelebi, who traveled throughout Eastern Asia in the year 970 of the Christian era. He played a blindfold match at Tripoli, Syria, but in this instance was permitted to touch the pieces to discover the position of the game.

The next instance on record is given by Giovanni Villani, in the seventh book of his History of Florence. He says:

"In these times, in the year of Christ 1266, there came to Florence a Saracen named Buzecca, a very great master of chess playing, and in the Palace del Popolo, before Count Guido Novello, he played at one time at three chess boards with the best masters of chess in Florence, playing at two by memory and at the third by sight. Two of the games he won, and the other he made a drawn game by perpetual check. This was esteemed a marvelous exploit."

In the preface to Salvio's Book on Chess, the editor writes:—

"The author was a first-rate chess player, as appeared by his playing from memory; and also by his new invention of playing blindfold, without seeing or being told the moves, but only by feeling the pieces."

Carrea says:—

"Zerone, Medrano, and Ruy Lopez (all Spaniards), and Magbdino of Florence played from memory; as likewise did Palo Bol, of Syracuse, with three chess boards."

Verei says:—

"Father Sacchieri, Lecturer of Mathematics in Pavia, played to perfection on four chess boards at the same time."

Keysler, in his account of Turin in 1740, says of him:

"The late Father Sacchieri, of Turin, was a remarkable instance of the strength of human understanding, particularly that faculty of the soul we term memory. He could play at chess with three different persons at the same time, even without seeing any one of the chess boards. He required no more than that his substitute should tell him what pieces his antagonist had moved; and Sacchieri could direct what step was to be taken on his side, holding, at the same time, conversation with the company present."

CHARLES H. WHEELER, OF ENGLEWOOD, ILL.

Since the days of Philidor, the recorded instances of games played without sight of the board and men would fill a volume. Almost every amateur has attempted it, and there are but few chess clubs (especially in this country) that cannot boast of its blindfold player.

To practice this agreeable art successfully requires a good memory, perfect familiarity with the relation of the squares to each other, and a considerable knowledge of the various openings. One should be able to calculate accurately and quickly, otherwise he will either lose, or take so much time for each move as to render the game tedious and wearisome.

Some give the blindfold player credit for possessing a sort of "second sight;" that the imagination pictures to the "mind's eye" the actual position of the board at each move, inspecting which they are enabled to calculate their combinations just as an ordinary player does by looking at the board. We need scarcely say that such statements are erroneous. The memory retains the position of the forces at every stage of the game, and the expert lays his plans with almost the same accuracy as if the board were before him, by the same process as the mind furnishes the figures in mental arithmetic.

With one as expert as Morphy or Paulsen, who can readily conduct fifteen games simultaneously, the odds is very slight when they play but one game without seeing the board. But, as a general rule, blindfold games are far less brilliant and interesting than those played in the usual manner. This practice is of great advantage to the student, however, as it strengthens the memory and improves the calculating powers; but it should not be indulged in to excess, for every one does not possess the extraordinary brain endurance of Morphy and Paulsen. Remember the sad experience of M. de La Bourdonnais, whose death, it is said, was caused by mental exertion in blindfold playing.

Our most celebrated American blindfold players have been Morphy, Paulsen, and Leonard, all of whom could readily play from ten to a dozen games simultaneously without sight of the board. These performances have been rivaled in Europe by Blackburne, Zukertort, and Rosenthal. The latter has just given an exhibition of blindfold play in Paris, whereas Mr. Blackburne, who is in all probability the strongest "British-born" player, has for many years been famous for his blindfold performances.

From the London *Field* we learn that the Old Change Chess Club, stimulated by the generous endeavors of its president, Mr. Greenhough, arranged the second blindfold performance which has taken place in the metropolis during the present season. Mr. Zukertort, only three weeks ago, accomplished the feat of beating all his opponents of this institution, while playing ten games simultaneously blindfold. On this occasion Mr. Blackburne was the performer, who conducted the same number of games without seeing either board or men. The team of the club played with great care, evidently anxious not to be defeated so wholesale as at the last exhibition, and their efforts were rewarded with success: for Mr. Mallett scored a victory on their behalf, and Messrs. Aldridge and Loyd each drew a game. The rest of the games were won by the blindfold player, and contained good specimens of his accustomed brilliancy and spirit. The president, Mr. Greenhough, and Messrs. Steinitz and Zukertort, acted in turn as tellers of the moves. Among the company present were the Rev. Mr. Williams, Messrs. Baxter, Bird, Cubison, Günzberg, Healey, Heywood, Hoffer, Walter Leaf, and Nathan.

The following we select as a specimen of Mr. Blackburne's wonderful skill:

MR. BLACKBURNE.	MR. FORD.
WHITE.	BLACK.
1. P to K 4	1. P to K 3
2. P to Q 4	2. P to Q 4
3. Kt to Q B 3	3. B to Kt 5
4. P x P	4. P x P
5. B to Q 3	5. Kt to Q B 3
6. Kt to B 3	6. Kt to B 3
7. Castles.	7. P to K R 3
8. R to K sq ch	8. Kt to K 2
9. Kt to K 5	9. Castles
10. Q to B 3	10. P to B 3
11. B x P	11. Kt to Kt 3
12. B to K Kt 5	12. B to K 2
13. B x Q Kt	13. P x B
14. Kt x K Kt P	14. R to B 2
15. B x Kt	15. B x B
16. Q to R 5	16. B to Q 2
17. R to K 3	17. R to Q 3
18. Q R to K sq	18. B to Q 2
19. R to K 7	19. B x R

And white announced mate in 8 moves.

As a memento of the unprecedented feat of playing sixteen games, we select one of the sixteen played by Herr Zukertort simultaneously, blindfold, at the West-end Chess Club, a few weeks since.

(*Evans Gambit.*)

MR. ZUKERTORT.	MR. MINCHIN.
WHITE.	BLACK.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to Q B 3
3. B to B 4	3. B to Q B 4
4. P to Q Kt 4	4. B x P
5. P to Q B 3	5. B to Q R 4
6. Castles.	6. Kt to K B 3
7. P to Q 4	7. Kt x K P
8. Kt x K P	8. Kt x Kt
9. P x Kt	9. Castles.
10. Q to Q 5	10. B x P
11. Kt x B	11. Kt x Kt
12. Q to K B 3	12. Kt to Q R 4
13. Q to K Kt 3	13. P to Q 4
14. B to R 6	14. P to K Kt 3
15. Q R to Q sq	15. Kt to Kt 3
16. B to Q 3	16. Q to Q 2
17. B x R	17. K x B
18. P to K R 3	18. Q to K 2
19. P to K B 4	19. B to B 4
20. B x B	20. P x B
21. Q to K B 3	21. Q to K 3
22. Q to R 5	22. Q to K Kt 3
23. Q to R 4	23. P to K R 3
24. R to K B 3	24. P to Q B 4
25. P to K Kt 4	25. R to Q B sq
26. R to K Kt 3	26. P x P
27. R x P	27. Q to K 3
28. P to B 5	28. Q x B P
29. Q x R P, ch, and mates in two moves.	

PROBLEM No. 65. BY SAMUEL LOYD.

"A la mémoire de Szen."—Second Prize, *Chess Monthly*, 1857.

Black.

White.

White to play and mate in three moves.